A prospective study of

COMPARISION OF FUNCTIONAL AND COSMETIC OUTCOME OF SUPRACONDYLAR FRACTURES IN CHILDREN TREATED BY PERCUTANEOUS PINNING AND OPEN REDUCTION AND INTERNAL FIXATION WITH K-WIRES

Dissertation submitted to

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BRANCH –II

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CERTIFICATE

This is to certify that **Dr.E.R.MITHUN,** post graduate student (2008-2011) in the Department of Orthopedic Surgery**, Government Royapettah Hospital/ Kilpauk Medical College ,** has done dissertation on **''COMPARISION OF FUNCTIONAL AND COSMETIC OUTCOME OF SUPRACONDYLAR FRACTURES IN CHILDREN TREATED BY PERCUTANEOUS PINNING AND OPEN REDUCTION AND INTERNAL FIXATION WITH K- WIRES''** under my guidance and supervision in partial fulfillment of the regulation laid down by the **'THE TAMILNADU DR MGR MEDICAL UNIVERSITY, CHENNAI -32'** for M.S.(Orthopaedic Surgery) degree examination to be held in April 2011.

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DECLARATION

I , **Dr.E.R. MITHUN** solemnly, declare that Dissertation titled ‘‘**COMPARISION OF FUNCTIONAL AND COSMETIC OUTCOME OF SUPRACONDYLAR FRACTURES IN CHILDREN TREATED BY PERCUTANEOUS PINNING AND OPEN REDUCTION AND INTERNAL FIXATION WITH K- WIRES’’** is a Bonafide work done by me at Government Royapettah Hospital / Kilpauk Medical College between 2008 to 2010, under the guidance and supervision of my unit Chief , **Prof.N. NAZEER AHMED M.S. (Ortho), D.Ortho.**

This dissertation is submitted to “**THE TAMILNADU DR MGR MEDICAL UNIVERSITY”**, towards partial fulfillment of regulations for the award of M.S.DEGREE BRANCH II in Orthopedic Surgery.

Place: Chennai

Date: **(DR.E.R.MITHUN)**

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Last but not the least I thank the **Almighty** for all his blessings, which has enabled me to accomplish whatever I have.

CONTENTS

INTRODUCTION

INTRODUCTION

Supracondylar fracture of humerus is the most common fracture in the children and needs proper management. This fracture is common in the first decade of life[1] due to various causes mainly ligament laxity and anatomical structure of humerus tube(shaft) to flat transformation at lower end of humerus. Its incidence decreases with age[2]**.** Its incidence is about 75% of fractures around elbow in children. Boys have a higher incidence than the girls. Common in left side or non dominant side.

There are two types of supracondylar fractures [3]

i) Extension type -- 97%

ii) Flexion type -- 3%

Mechanism of injury in extension type is fall on the out stretched hand with hyper extension at the elbow with abduction or adduction, with dorsiflexed hand. Flexion type occurs as a result of direct blow to elbow from behind.

Various modes of treatment are:-

i) Closed reduction and casting.

ii) Percutaneous Pinning.

iii) Open reduction and internal fixation.

The early complications of supracondylar fractures include vascular and nerve injuries and the late complications include Volkmann's ischemic

contracture, Myositis ossificans, Cubitus varus or valgus deformity, Tardy ulnar nerve palsy.

Supracondylar fractures of humerus need to be handled carefully to avoid drastic short term complications and vexing long term complications. The complications can be prevented by early and proper intervention. This can be achieved by proper anatomical reduction and maintenance of reduction either by percutaneous pinning or ORIF.

A I M

AIM OF THE STUDY

The aim of the study is to **" COMPARE THE FUNCTIONAL AND COSMETIC OUTCOME OF SUPRA CONDYLAR FRACTURES OF HUMERUS IN CHILDREN TREATED BY PERCUTANEOUS PINNING AND ORIF WITH KIRSCHNER WIRES"** at the Department of Orthopaedics & Traumatology, Government Royapettah Hospital/Government Kilpauk Medical College, between June 2008 and October 2010.

HISTORICAL REVIEW

AND LITERATURE

HISTORICAL REVIEW AND LITERATURE

Supracondylar fractures were described in the early writings of Hippocrates during the 3rd and 4th century A.D [(4)]. Until 1700s it was not written about supracondylar fractures in the classical medical literature.

Most of the discussion during the 1700s and 1800s was directed towards the controversy in the correct position of immobilization.

Desault from Paris in 1800 said that poor results were due to poor management and not inevitable with this type of fractures. He demonstrated better results with prompt recognition and careful management of the fractures.

Dupuytren mentioned the findings of crepitus with the fracture, Malgaigne[(5)] demonstrated that there was preservation of the olecranon – humerus condylar relationship with the fracture but not with dislocation.

Jones and Thomas propounded treatment in flexed position, which we follow now, while Listen and Allis were in favour of an extended position.

At the beginning of the 29th century, treatment began to change from these simple passive methods to more aggressive and active methods. Scientific reason and study began to alter the methods of treatment and open reduction and internal fixation came into vogue.

Herzenberg & Co workers conducted invitro studies of pin stability and found the 5/64" Steinmann's pins placed from medial to lateral entrance points provided the best stability[6].

Zionts and Co workers demonstrated the resistance of various pin patterns to rotational stresses[7].

Cheng JC. Lam TP. Shen WY and Co workers conclude that cross pinning was found to be effective in the treatment of Gartland type III extension type with a high success rate and minimal complications [8].

Mohamed S. and Rymaszewski LA., in a study conducted at the Glasgow Royal Infirmary between June1990 and September 1992, on 32 displaced supracondylar fractures of the humerus in children conclude that open reduction and internal fixation with K-wires gave the best results.

Aronson DC. Van Vollendhoven E. Meeuwis JD [9] in a study conducted on 11 children with supracondylar fractures of the humerus treated with open reduction and K- wire fixation by a ventral approach concluded that K-wire fixation of supracondylar fractures in children gives excellent results.

Furrer M. Mark G. & Ruedi T[10] did a open reduction and crossed K-wire fixation on 33 children with displaced supracondylar fractures of the humerus and recommended that it is the ideal mode of it of treatment.

Royce RO. Dutkowsky JP. Kasser JR. & Rand FR[11] , in a study done on 143 supracondylar humerus fractures in children treated with K-wire fixations say that they encountered only four ulnar neuropraxias which recovered within 3 months.

The ability to maintain an adequate reduction results in a marked decrease in the incidence of complications. We can achieve this by fixation of fractures with K-wires either by percutaneous pinning or ORIF .

ANATOMY

ANATOMY

The elbow is a complex joint composed of three individual joints the ulnohumeral, radiocapitellar, and proximal radioulnar with a common articular cavity.

DISTAL END OF HUMERUS:

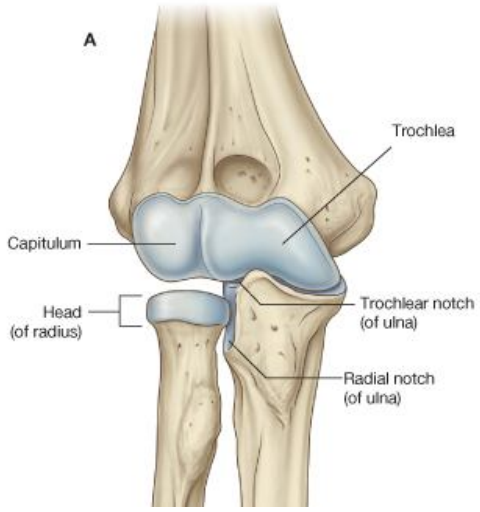
The distal aspect of humerus is divided into medial and lateral columns. Each of the columns are roughly triangular and is bound on its one of its borders by a supracondylar ridge.

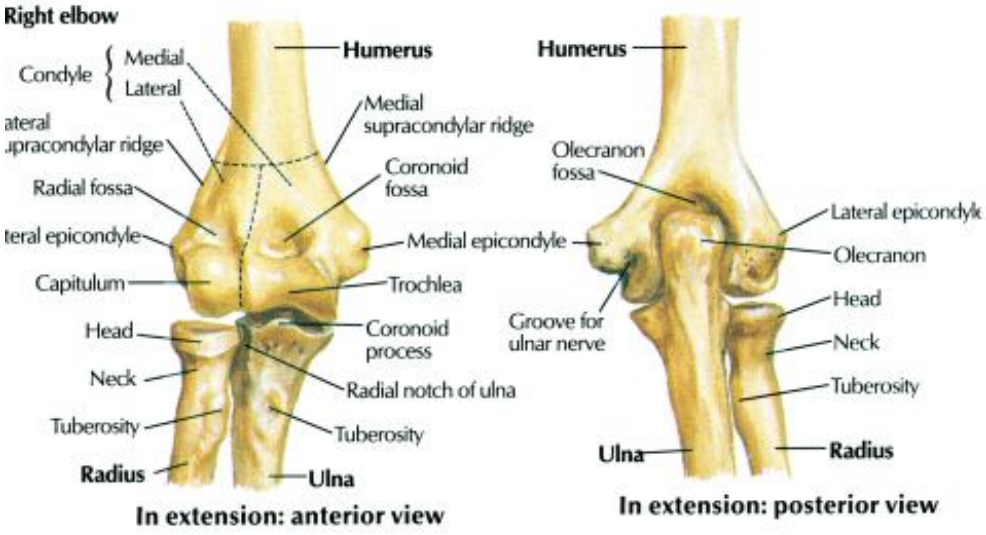
From the structural and functional stand points the distal humerus is divided into separate medial and lateral components each containing an articular and non-articulating portion. Included in the non-articulating portion are the epicondyle which are the terminal points of the supracondylar ridges. The lateral epicondyle contains a roughened anterolateral surface from which the superficial forearm extensor muscles arise. The medial epicondyle is larger than the lateral counter part and serves as the origin of forearm flexor muscles.

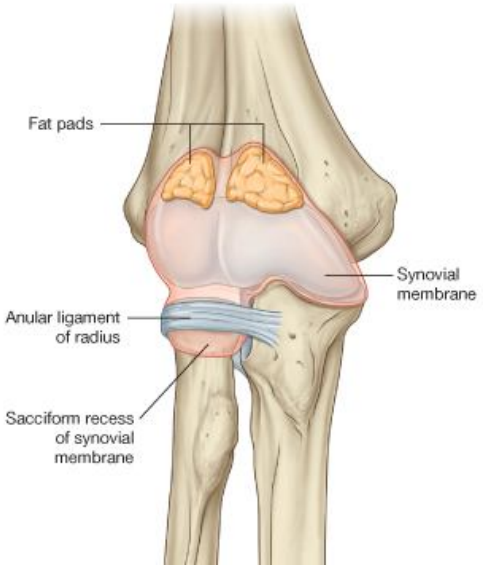
The posterior distal portion of the medial epicondyle is smooth and in contact with the ulnar nerve as it crosses the elbow joint.

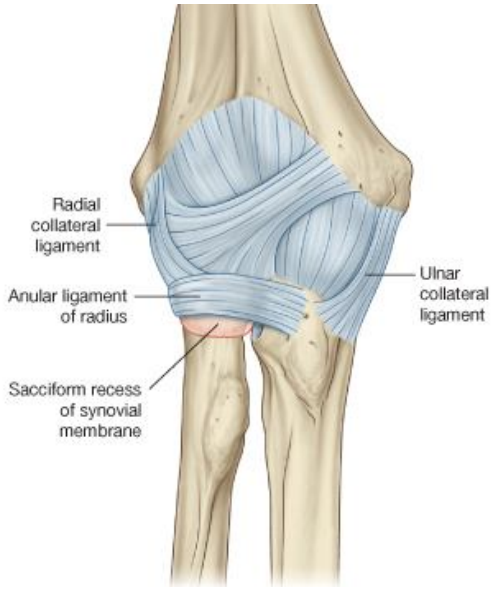
When a condyle losses continuity from its supporting column, as in a fracture displacement, the nerve can get injured by direct compression by the fractured fragments. This should be well born in mind while treating supracondylar fractures.

ANATOMY


A
Trochlea
Capitulum
Head
(of radius)
Trochlear notch
(of ulna)
Radial notch
(of ulna)


Right elbow
Humerus
Condyle
Medial
Lateral
Medial
supracondylar ridge
ateral
upracondylar ridge
Coronoid
fossa
Radial fossa
teral epicondyle
Medial epicondyle
Capitulum
Trochlea
Head
Coronoid
process
Neck
Radial notch of ulna
Tuberosity
Tuberosity
Radius
Ulna
In extension: anterior view
Humerus
Olecranon
fossa
Lateral epicondyle
Olecranon
Groove for
ulnar nerve
Head
Neck
Tuberosity
Ulna
Radius
In extension: posterior view


Fat pads
Synovial membrane
Anular ligament of radius
Sacciform recess of synovial membrane


Radial collateral ligament
Ulnar collateral ligament
Anular ligament of radius
Sacciform recess of synovial membrane

The articulating surface of the medial condyle, the trochlea, is more cylindrical or spool like.

It has very prominent medial and lateral ridges. Between these ridges is a central groove that articulate with the greater sigmoid notch of proximal ulna.The groove originates anteriorly in the coronoid fossa and terminates in the olecranon fossa, on the posterior surface of the trochlea the groove is directed slightly laterally.

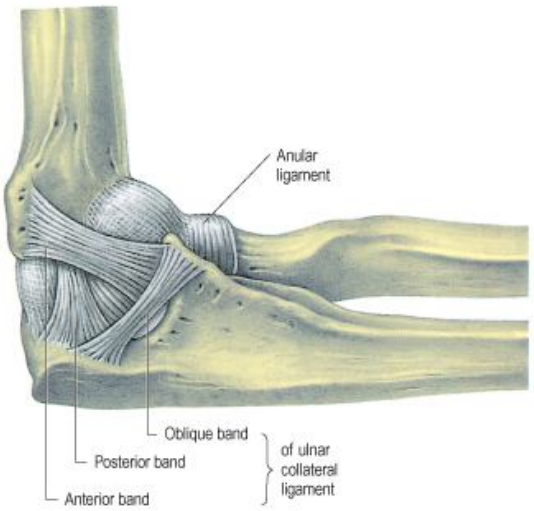
The obliquity of the trochlear groove produces the valgus carrying angle of the forearm when the elbow is extended. Obliteration of this carrying angle is one of the most important complications of supracondylar fractures.

Proximal to the condyles on the anterior surface of the humerus lies the coronid and radial fossa. They receive the coronoid process and the radial head respectively when the elbow is flexed. Posteriorly the olecranon fossa is a deep hollow for the perception of olecranon process, making it possible for the elbow to go into full extension. The bone that seperates this anterior and posterior fossa is extremely thin and translucent.

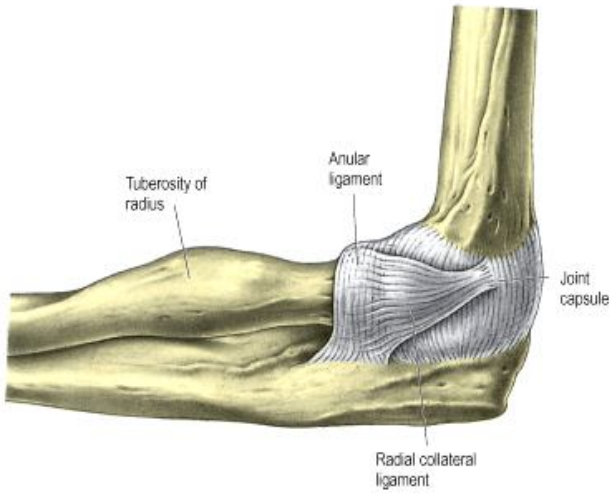
UPPER END OF ULNA:

The proximal end consists of the olecranon and the coronoid process, which together form the semilunar notch. The triceps inserts by a broad tendinous

A


Anular ligament
Oblique band
Posterior band
Anterior band
of ulnar collateral ligament

B


Tuberosity of radius
Anular ligament
Joint capsule
Radial collateral ligament

insertion into the olecranon posteriorly. On the anterior surface, the brachialis muscle inserts into the coronoid process.

The triceps play an important role in maintaining the reduction of supracondylar fracture and its integrity is important for that and to avoid extensor lag.

UPPER END OF RADIUS:

The proximal end of radius consist of the disk shaped head, the neck and the radial tuberosiy. The head and part of the neck lie within the joint. The shallow concavity of head articulate with the capitellum.

COLLATERAL LIGAMENTS:

The collateral ligaments supplement the natural stability of elbow joint. The fan shaped radial collateral ligament originate from the lateral condyle and inserts into the annular ligament of the radius. The thicker and stronger ulnar collateral ligament is triangular in shape and consists of two portions anterior and posterior, both arising from the medial condyle. Anterior band is attached to coronoid process and posterior band is attached to the olecranon process.

SUPRACONDYLAR AREA OF THE HUMERUS IN CHILDREN:

There is a considerable difference in the bony architecture of the supracondylar area in the adult and child.

At the age of peak incidence for supracondylar fractures, 6½ years , the bone in the supracondylar area is undergoing remodeling with a decrease in both anteroposterior and lateral dimensions. It is less cylindrical than in the adult. The metaphysis of the 6½ years old extends just distal to the two fossa. Because this is a newly formed bone, the trabeculae are less defined and thinner and the cortex is very slender.

In the lateral projections the anterior cortices of the medial and lateral supracondylar column do not project as far anteriorly as the condyles thus producing an anterior defect in the area of coronoid fossa.

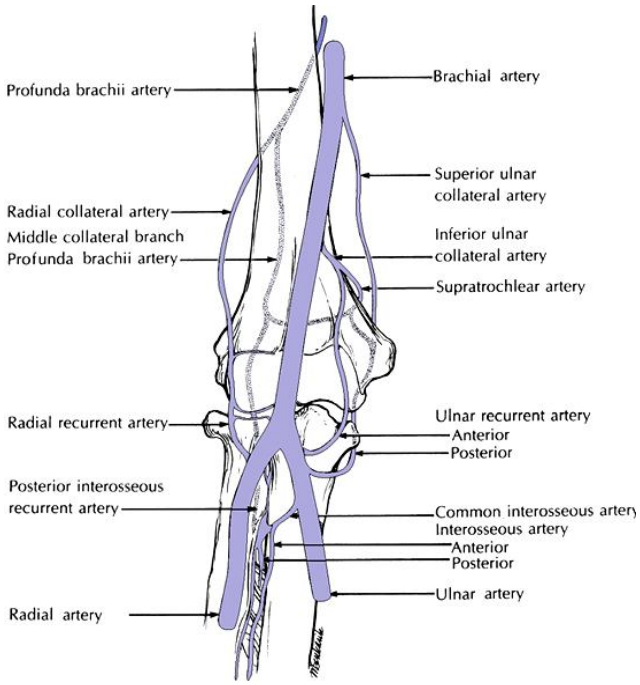
LIGAMENTOUS LAXITY:

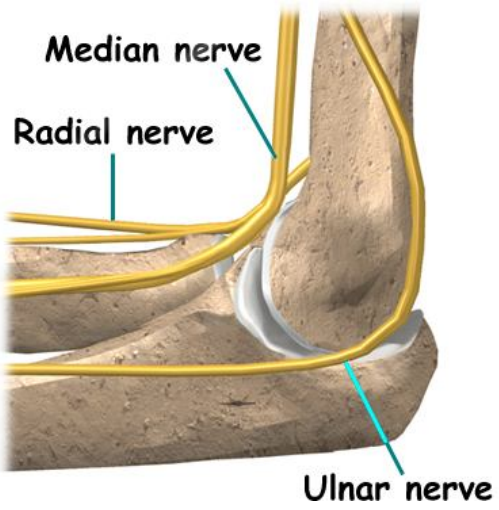
Ligamentous laxity with hyperextension of joints is normal in younger children[(12)]. Thus as the younger child falls with the arm outstretched, the elbow is more likely to be hyperextended at the time of the fall.

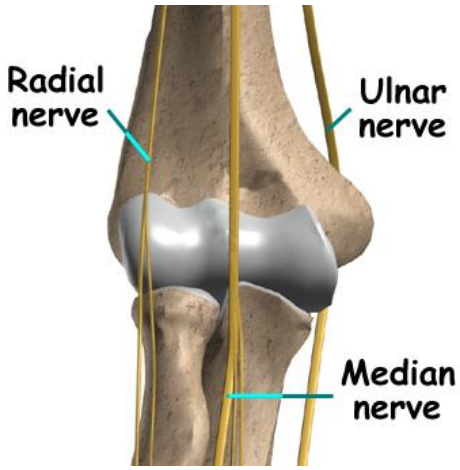
Thus the local bony and ligamentous anatomy is a major factor in producing supracondylar fracture during the first decade of life.

NEURO VASCULAR ANATOMY OF THE DISTAL HUMERUS AND ELBOW:

Unless the orthopedic surgeon is well versed with neuro vascular arrangement in distal humerus and elbow, he cannot do much to the young patient. The vascularity to the elbow is a broad anastomotic network that forms


Profunda brachii artery
Brachial artery
Superior ulnar collateral artery
Radial collateral artery
Middle collateral branch
Profunda brachii artery
Inferior ulnar collateral artery
Supratrochlear artery
Radial recurrent artery
Ulnar recurrent artery
Anterior
Posterior
Posterior interosseous recurrent artery
Common interosseous artery
Interosseous artery
Anterior
Posterior
Ulnar artery
Radial artery


Median nerve
Radial nerve
Ulnar nerve


Radial nerve
Ulnar nerve
Median nerve

the intraosseous and extraosseous blood supplies[13]. The brachial artery is the most important artery in the anterior aspect of the distal end of humerus. This is the most common vascular structure to be involved in extension type of supracondylar fracture.

The capitellum is supplied by a posterior branch of the brachial artery that enters the lateral crista.

The trochlea is supplied by a medial branch that enters along the nonarticular medial crista and a lateral branch that crosses the physis.

There is no anastomotic connection between these two vessels.

The median nerve lies medial to the brachial artery which can also be injured.

The radial nerve may be injured if the spike is displaced laterally.

The ulnar nerve passes posterior to the medial epicondyle in the ulnar tunnel and emerges in the anterior aspect winding around the medial epicondyle. This may be injured in flexion type of supracondylar fractures.

Median nerve is the commonest nerve to be injured.

PATHOLOGY

OF FRACTURE

PATHOLOGY OF FRACTURE

To evaluate and treat supracondylar fractures one must understand the pathology of the fracture and the associated soft tissue injury.

IN THE CORONAL PLANE:

Supracondylar fractures are by definition extraarticular. Most often the point of fracture is the thin bone between the medial and lateral column of the distal humerus.

The fracture is transverse extending from just above the epicondyle and entering the thin area separating the coronoid and olecranon fossa. The fracture line is totally metaphyseal, lying usually at the anterior and posterior capsular origins. In many cases sharp protruding spikes involve the conical process of the respective supracondylar ridges. These sharp medial and lateral spikes of bone can damage the surrounding soft tissues, and may be an impediment to the reduction of fracture segments.

Kocher[14] described the extension type supracondylar fracture as starting proximal-posterior and extending obliquely to anterior-distal. However more recent clinical studies by Holmberg & Nand[15] have demonstrated that the fracture pattern is transverse on lateral x-rays in more than 80% of cases. Thus it appears that the fracture line is most commonly transverse in both anteroposterior and lateral projections.

ROLE OF PERIOSTEUM:

In suspracondylar fractures the failure of periosteum during fracture progresses in 3 stages.

In the first stage, the fracture is minimally displaced with minimal periosteal change. The periosteum while intact stretches across the anterior fracture site and detached from the anterior surface of humerus for a considerable distance proximally.

In the second stage, the fracture becomes more displaced and the detached periosteum is torn as it is pulled distally across the sharp edge of proximal fragment. This might leave a gap anteriorly.

The final stage represents complete displacement. At this point the periosteum is completely torn anteriorly. The periosteum is intact posteriorly and to some degrees medially and laterally. A portion of periosteum remains attached to the distal fragment.

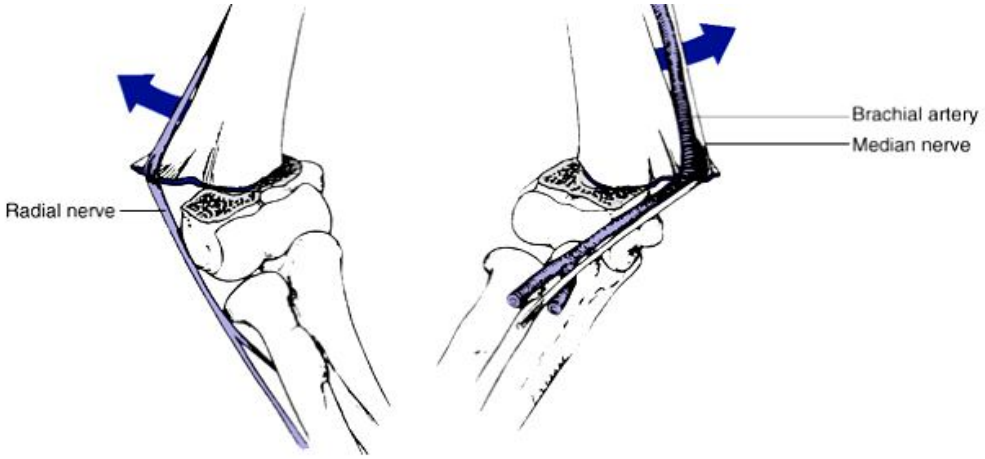
This can become interposed between the edges of fracture fragments to prevent complete reduction.

In flexion type of injuries it is the posterior periosteum which is torn first[(16)].

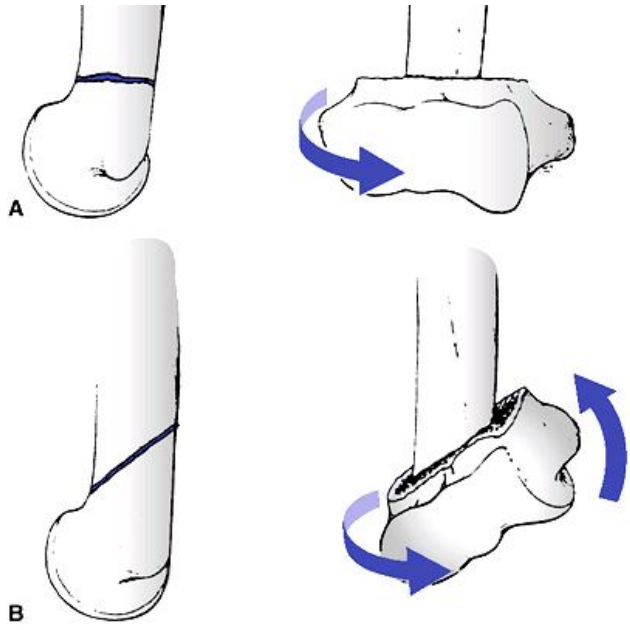
MEDIAL VERSUS LATERAL DISPLACEMENT:

Postero medial displacement is the most common displacement and it account for 75% of displaced supracondylar fractures[9].

PATHOLOGY



POSTEROMEDIAL AND POSTEROLATERAL DISPLACEMENT



EFFECT OF OBLIQUITY OF FRACTURE LINE

The postero medial displacement is probably secondary to the pull of triceps, which originates more medially than biceps. Postero medial displacement may injure the radial nerve[17].

In postero lateral displacement, the brachial artery and median nerve may be injured.

CLINICAL SIGNIFICANCE:

The differentiation between postero- medial and postero-lateral displacement is important because

1) If it is posterolateral, there is a greater chance of vascular injury. In this pattern the medial spike of the proximal fragments is more likely to impinge on the brachial artey.
2) If an open reduction is contemplated the surgical approach has to be decided according to the displacement.
3) It gives an indication of residual deformity.

Posteromedial fractures have a higher incidence of varus angulation.

In posteromedial fracture there is a tendency for the distal fragment to rotate internally, whereas posterolateral fractures tend to rotate externally.

OBLIQUITY:

If the fracture line is oblique, rotation of the distal fragment produces a secondary distal angulation.

In most supracondylar fractures the brachialis muscle protects the anterior neurovascular structures from injury.

ROTATIONAL DISPLACEMENT:

The distal humeral condyles are rotated normally 5 degree medial to the shaft. With supracondylar fracture there is often a loss of rotation alignment of the shaft with condyles. If not appreciated this can lead to a permanent cosmetic deformity

Usually there is a medial rotation of the distal fragments.

BIOMECHANISM AND MECHANISM OF INJURY

BIOMECHANICS AND MECHANISM OF INJURY

The bone in the supracondylar area is weaker during the last part of first decade of life because it is undergoing metaphyseal remodeling. The thinnest portion occurs at the depth of olecranon fossa.

In addition, the large amount of elastic epiphyseal and articular cartilage in the distal portion can serve as a buffer to transfer the force of hyperextension injury to supracondylar area[18].

The uniqueness of the juvenile elbow to develop supracondylar fracture from a hyperextension mechanism has been demonstrated in two cadaver studies[19].

EXTENSION TYPE OF INJURY

The mechanism of fracture in this type of injury includes

1) Hyperextension.
2) Abduction or adduction of elbow.
3) A fall on the outstretched hand with dorsiflexion of hand and the elbow in extension[20].

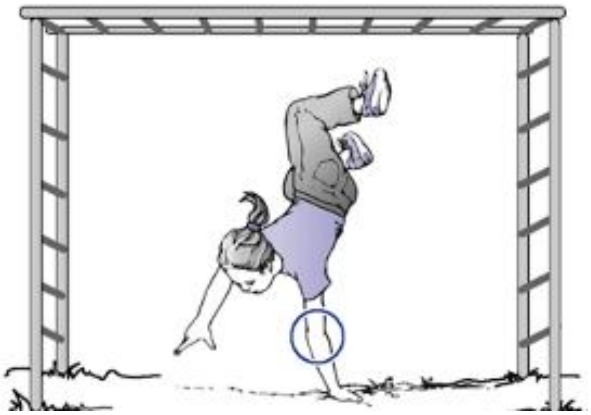
The three major factors that seen to contribute to the unique predisposition of the juvenile humerus to supracondylar fracture are:

i) Ligamentous laxity

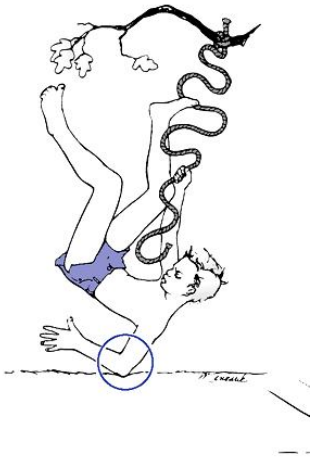
ii) Relation of the joint structre and bony stucture in hyperextension

iii) Bony structure.

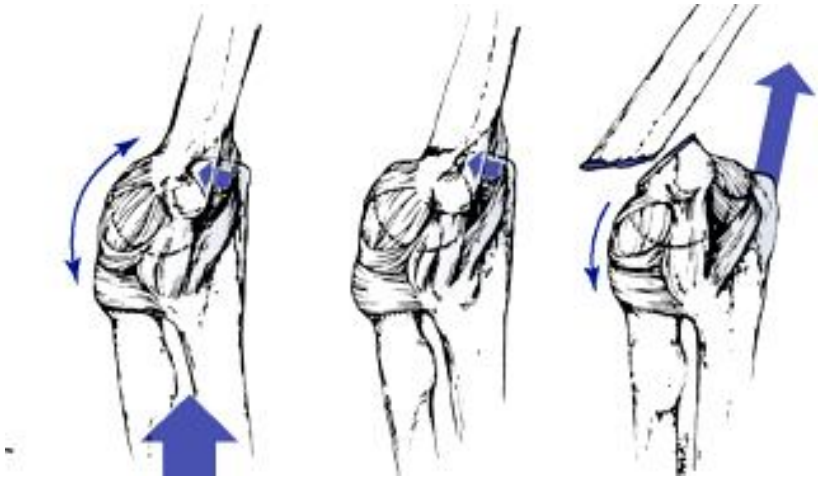
BIOMECHANISM



HYPEREXTENSION



FLEXION



HYPER EXTENSION FORCES

HYPEREXTENSION

The child's ligaments are especially lax. This allows for hyper extensibility of the joints.

RELATION OF JOINT STRUCTURES IN HYPEREXTENSION

The anterior capsule and anterior portion of the collateral ligament become taut in hyperextension and reinforce the tension forces anteriorly. The elbow becomes fixed and interlocked with the tip of olecranon into its fossa.

When the forces exceed the strength of bone a supracondylar fracture is produced.

FLEXION TYPE OF INJURIES

Usually they result from a blow to the posterior aspect of elbow with the elbow in flexion either fully or partially flexed. The obliquity of fracture line may be opposite to an extension type of injury.

CLASSIFICATION

CLASSIFICATION

Classification of fracture type is useful only if it enables the surgeon to make a decision about treatment or provide some type of prognosis.

Since Extension type of supracondylar fracture is the commonest type 97% whereas flexion type is 3%, numerous attempts have been made to classify extension type of fracture.

These initial classifications have been based on two factors.

1) The type and location of fracture line.
2) The degree of displacement.

The classifications are:

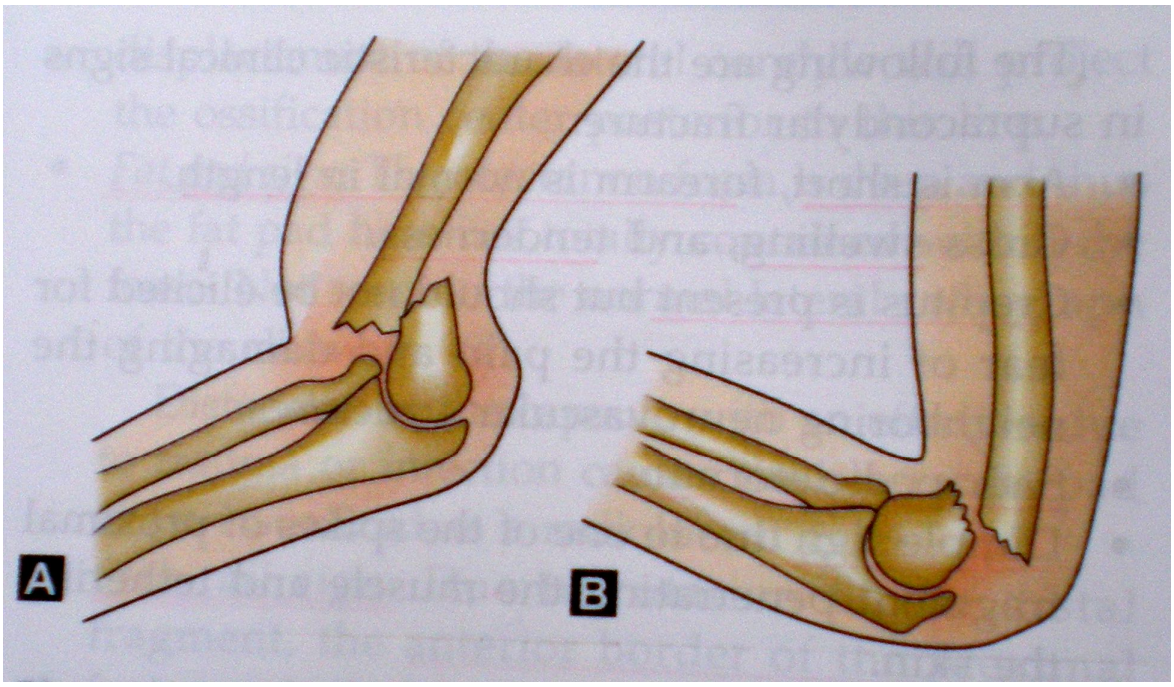
1) Marion
2) El Ahwaney
3) Gartland and
4) A.O. classification

1. MARION

He classified supracondylar fractures according to the position of fracture line.

a. Fracture line passing proximal to olecranon fossa
b. Fracture line passing through the olecranon fossa
c. Fracture line passing distal to olecranon fossa.

CLASSIFICATION



EXTENSION TYPE **FLEXION TYPE**

GARTLAND'S TYPE I

UNDISPLACED FRACTURE.

2. EL AHWANEY

He classified the fracture according to the position of the displacement of fracture fragment and the obliquity of the fracture line.

Type I - Without displacement

Type II - Posteromedial displacement

Type III - Posterolateral displacement

Type IV - Oblique fracture line with posteromedial or posterolateral or rotational displacement

The type IV produced maximum morbidity.

3. GARTLAND'S CLASSIFICATION

In 1959 Gartland described 3 stages based on the degree of displacement[21].

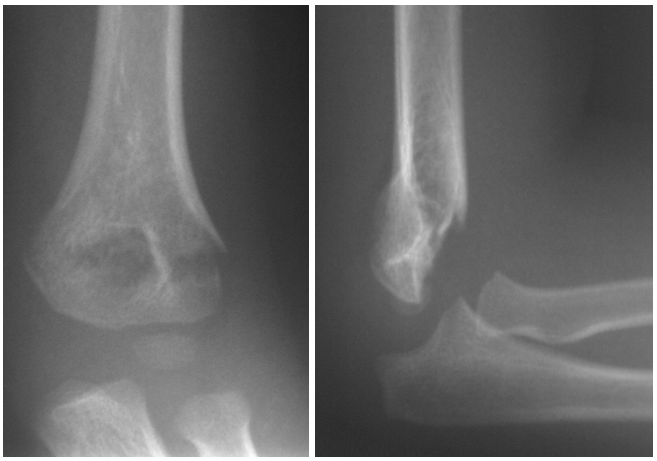
Type I - Undisplaced.

Type II - Displaced with intact posterior cortex; may be angulated or rotated.

Type III - Completely displaced; posteromedial or posterolateral

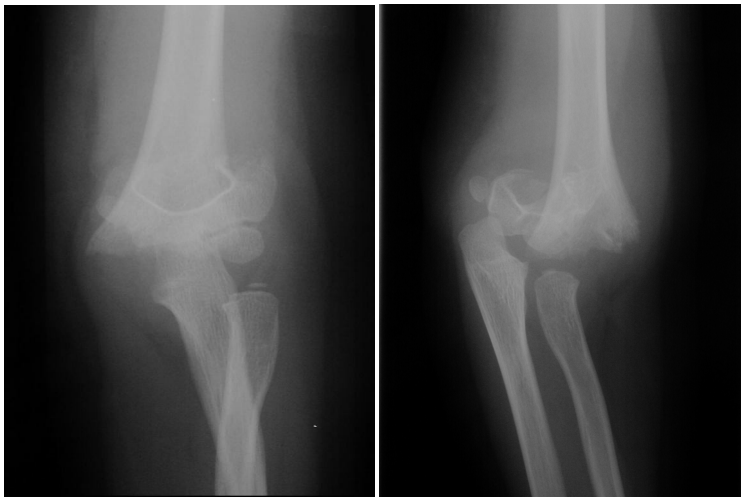
4. A.O. CLASSIFICATION

It comes under A 2 (simple metaphyseal transcolumn fractures) in the broad classification of fractures of distal end of humerus[22].



GARTLAND'S TYPE II

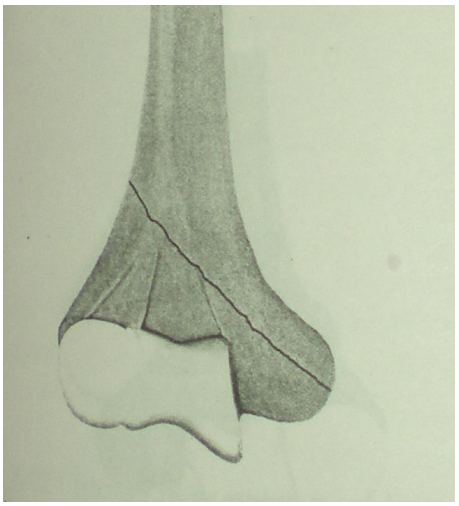
DISPLACED WITH INTACT POSTERIOR CORTEX; MAY BE ANGULATED OR ROTATED.



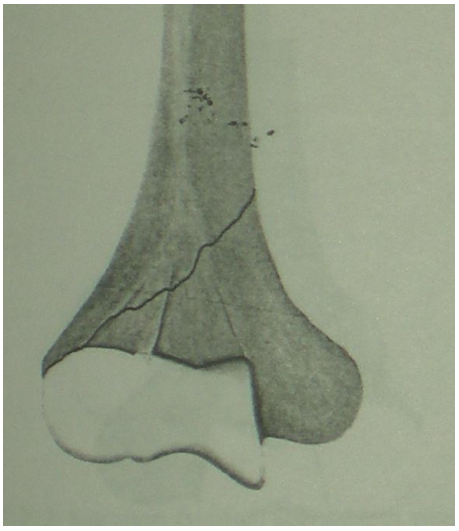
GARTLAND'S TYPE III

COMPLETELY DISPLACED; POSTEROMEDIAL OR POSTEROLATERAL.

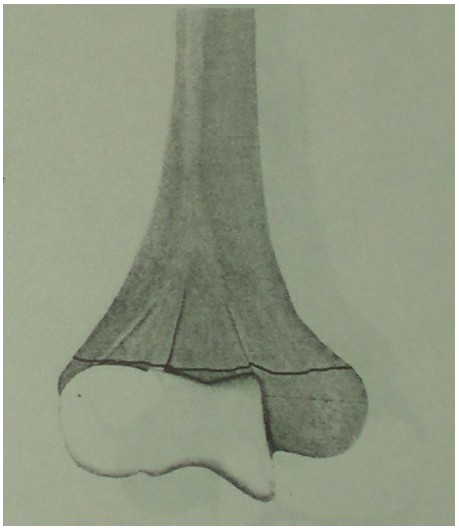
AO CLASSIFICATION OF DISTAL HUMERUS



A 2. 1 FRACTURE LINE OBLIQUE DOWNWARD AND INWARD



A2. 2 FRACTURE LINE OBLIQUE DOWNWARD AND OUTWARD



A2. 3 FRACTURE LINE TRANSVERSE

A2-1 : The fracture line lies obliquely downwards and inwards.

A2-2 : The fracture line lies obliquely downwards and outwards.

A2-3 : The fracture line is transverse.

The flexion type of injury is very rare and a useful classification does not exists in the context of the true meaning of classification as said earlier.

DIAGNOSIS

DIAGNOSIS

Diagnosis is relatively simple, with some difficulties only in classifying the fracture. Apart from the classical signs and symptoms of fracture namely

i) Pain

ii) Swelling

iii) Tenderness

iv) Inability to use the limb

v) Crepitus

the diagnosis was made on the following clinical criteria.

1. DEFORMITY:

In type III supracondylar fracture there might be 'S' shaped deformity produced by the fracture fragments. Because in the distal fragment there is also flexion of elbow there is an anterior concavity which accentuates the 'S' shaped configuration.

2. PUCKER SIGN:

A dimple in the skin is produced if the spike of the proximal fragment has penetrated the brachialis muscle. The anterior portion of the distal arm often presents with subcutaneous haemmorhage.

3. ANCONEUS SOFT SPOT:

In type I and II supracondylar fracture the diagnosis is less obvious, with a swollen elbow as the only clinical sign. This can be felt in the soft spot under the anconeus muscle, where the capsule of the elbow joint is most superficial.

4. ROTATION AND ANGULATION:

The forearm which follows the distal fragment tends to be internally rotated in relation to the shaft of the humerus. A lateral rotation, though rare might produce valgus deformity.

DIFFERNTIATION FROM DISLOCATION OF ELBOW:

The major diagnostic difficulty lies in the differentiating an extension supracondylar fracture from an acutely displaced elbow. In supracondylar fracture the triangular relation between the olecranon and two epicondyles is maintained. With elbow dislocation the relationship is not maintained and the olecranon is more prominent because it is posterior to the epicondyle.

Also the prominence in the anterior arm is more distal with dislocation than with a supracondylar fracture.

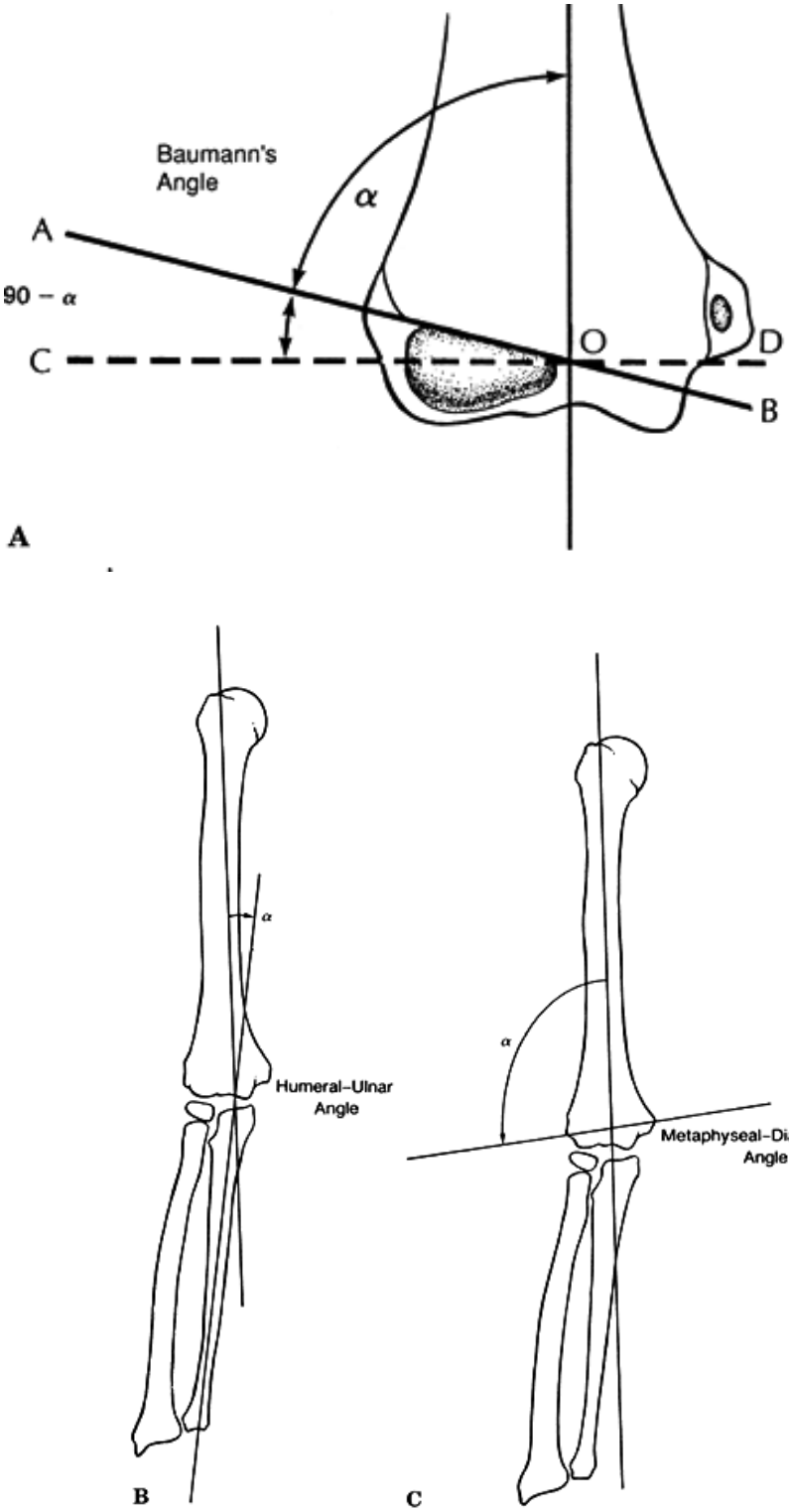
X-RAY DIAGNOSIS:

The X-rays used are

1) Standard anteroposterior and lateral view.

2) Jone’s view.

DIAGNOSIS


Baumann's
Angle
α
A
90 − α
C
O
D
B
A
α
Humeral–Ulnar
Angle
B
α
Metaphyseal–Diaphyse
Angle
C

The radiological diagnosis was difficult in Type I fractures and minimally displaced Type II fractures.

ANTEROPOSTERIOR VIEW:

1. Bauman's angle.
2. Humeral ulnar angle.
3. Metaphyseal-diaphyseal angle.

1. Bauman's angle

The angulation of the lateral condylar physeal line and the long axis of humerus. Normal is 15-20 degrees and equal to the opposite side.

2. Humeral- ulnar angle

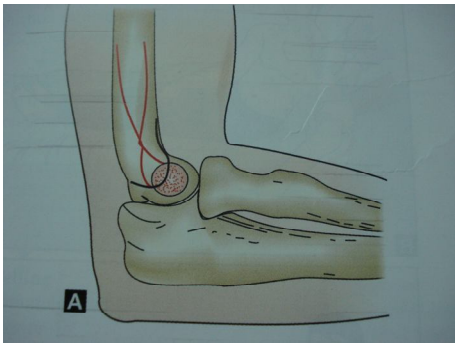
This angle is subtended by the intersection of the diaphyseal bisectors of the humerus and ulna. This is the best angle which reflects the true carrying angle.

3. Metaphyseal-diaphyseal angle

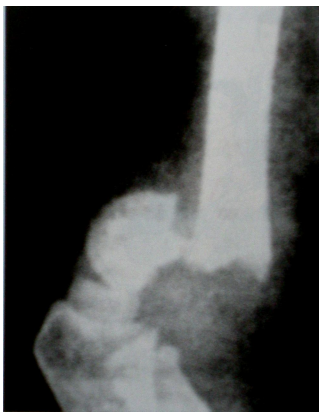
This angle is formed by a bisector of the humeral shaft with respect to a line delineated by the widest points of the distal humeral metaphysic.

LATERAL VIEW:

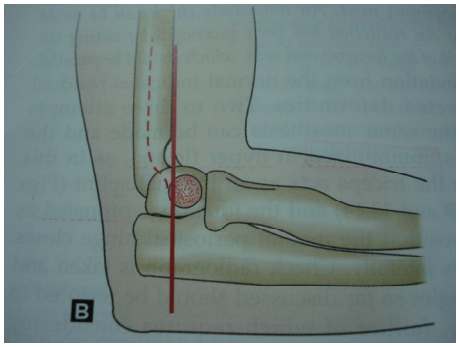
1. Tear drop sign
2. Fish tail sign
3. Crescent sign
4. Anterior humeral line



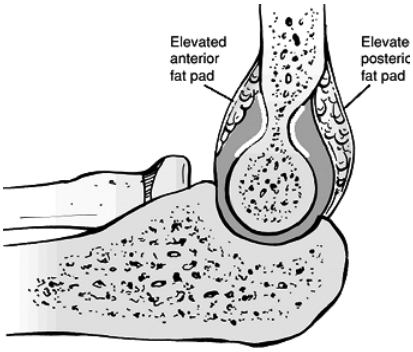
TEAR DROP SIGN



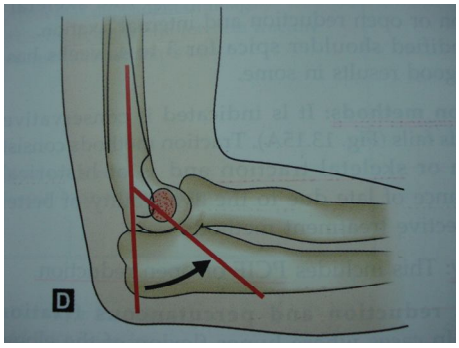
FISH TAIL SIGN



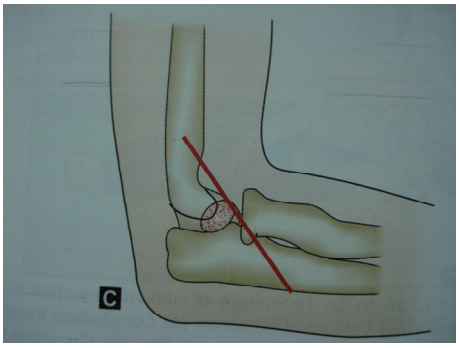
ANTERIOR HUMERAL LINE



FAT PAD SIGN



SHAFT CONDYLAR ANGLE



CORONOID LINE

5. Fat pad sign
6. Shaft condylar angle
7. Coronoid line

1) Tear drop sign:

Tear drop radiographic shadow is formed by the posterior margin of the coronoid fossa anteriorly, the anterior margin of the olecranon fossa posteriorly and the superior margin of the capitellar ossification centre inferiorly. This is disturbed in supracondylar fracture.

2) Fish- tail sign:

Due to the rotation of the distal fragment, the anterior border of the proximal fragment looks like a sharp spike.

3) Crescent sign:

The radiolucent gap of the elbow joint is missing and a crescent shaped shadow due to the overlap of the capitulum over the olecranon is evident and indicates varus or valgus.

4) Anterior humeral line:

A line drawn along the anterior border of the distal humeral shaft should pass through the middle $1/3^{rd}$ of capitellum. If it is displaced ,the lateral condyle will project the ossification centre posterior to this line.

5) Fat pad sign:

a) Anterior (coronoid)fat pad

b) Posterior (olecranon) fat pad

c) Supinator fat pad

These are the areas in which fat pads overlie the elbow's major structures. Displacement of any of the fat pads can indicate an occult fracture. The first two areas are the fat pads that overlie the capsule in the coronoid fossa anteriorly and the olecranon fossa posteriorly.

Displacement of either or both of these fat pads is usually referred to as the classic elbow fat pad sign. A third accumulation of fat overlies the supinator muscle as it wraps around the proximal radius.

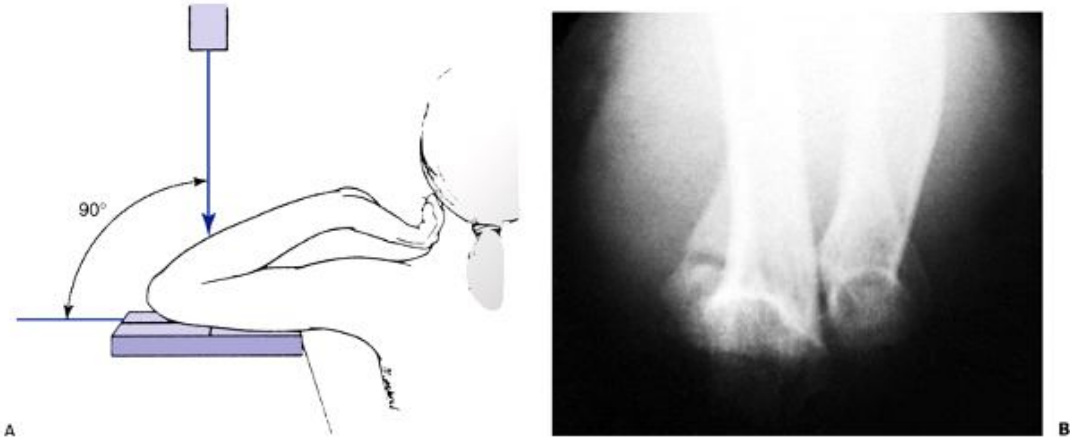
6) Shaft condylar angle:

There is an angulation of 45° between the long axis of humerus and long axis of lateral condyle. This is disturbed in supracondylar fracture.

7) Coronoid line:

The line directed proximally along the anterior border of coronoid process of ulna should touch the anterior portion of the lateral condyle. Posterior displacement of the lateral condyle will project the ossification centre posterior to this line.

JONES VIEW



JONE'S VIEW:

It is difficult for a child to extend the injured elbow and an axial view of the elbow (Jones view) [23] may be helpful. The elbow is hyper flexed and the cassette is placed below the arm. The beam is projected 90 degrees to the cassette.

MANAGEMENT

IN VOGUE

MANAGEMENT IN VOGUE

A neurological evaluation and vascular assessment should be done initially. Management can be broadly classified into

1. Closed manipulation and reduction.
2. Traction.
3. Open reduction and internal fixation.
4. Percutaneous pinning.

TYPE I FRACTURES:

These are managed by simple immobilization. The limb is placed in a posterior above elbow slab or circular cast.

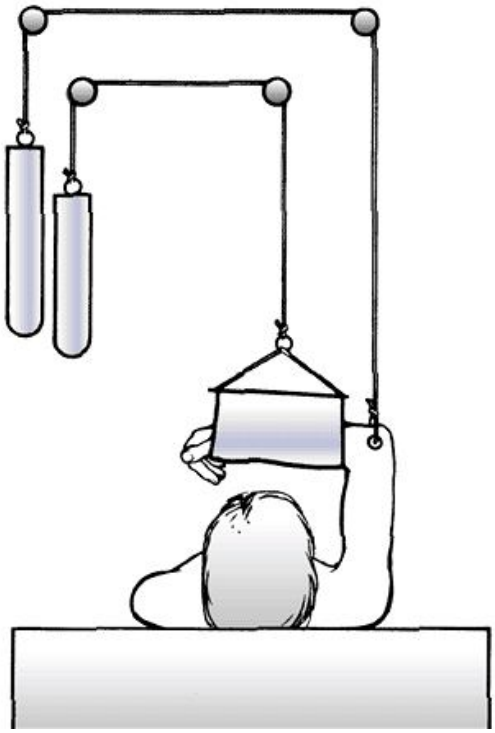
TYPE II FRACTURES:

1. **Manipulation to correct angulation**

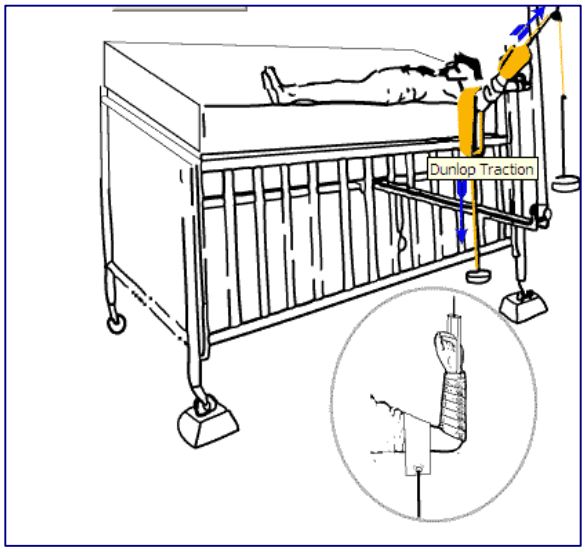
   The key to treatment of type II fracture is to determine if there is enough intrinsic stability so that the fracture is stable when reduced and maintained in a safe degree of flexion (120°).

2. **Reduction**

   Sir Ashley Cooper's method of reduction still holds good. Longitudinal traction, correction of displacement and flexion to 120° of the elbow is the main stay of treatment. If the initial displacement is medial, then the forearm is placed in full pronation which tightens the medial hinge. The radial pulse is checked after reduction and if not felt



OVER HEAD TRACTION



DUNLOP TRACTION

the flexed elbow Is extended till the pulse is felt.

3.Traction

Overhead olecranon pin traction gives very good results. But they might lead to ulnar nerve palsy.

A Dunlop traction may also be used.

TYPE III FRACTURES:

These are completely displaced fractures. They need to be stabilized by some form of internal fixation. The methods currently used are

1) Percutaneous pinning.
2) Open reduction and internal fixation.

In both the above said methods , 2 criss cross K-wires , 2 laterally placed K-wires or 2 lateral and one medial K-wires can be used depending on the stability of the fracture.

1. Percutaneous pinning:

This can be done as a crossed pinning or passing two K-wires parallel to each other from the lateral epicondyle. No difference was found in the results[(24)]. This procedure needs C-arm.

2. Open reduction and pinning:

Open reduction and internal fixation with two K-wires is easy because there is direct visualization of fracture site and C-arm is not needed. Mohammed et al[25] suggested ORIF is the optimal method of treatment.

In both of these methods, where criss cross wires were used, both the wire were inserted at 30 degrees to the shaft of humerus. The wire should cross the fracture site and have a good purchase on the opposite cortex.

MATERIALS AND METHODS

MATERIALS AND METHODS

In this series of prospective study, 20 cases of supracondylar fractures Type II and Type III were managed out of which 10 cases were treated by Open Reduction and Internal Fixation, and the other 10 cases were treated by Percutaneous pinning. The study was carried out from June 2008 to October 2010, at the Department of Orthopaedic Surgery and Traumatology, Government Royapettah Hospital, Chennai. The cases were included in the study, depending on the following inclusion and exclusion criterias.

Inclusion criteria:

i) GARTLAND'S type II and III.

ii) Patient less than 12 years.

iii) Closed supracondylar fractures.

Exclusion criteria :

i) GARTLAND'S type I.

ii) Open supracondylar fractures.

iii) Patients with nerve injury.

iv) Fractures with compartmental syndrome.

v) Fractures needing vascular repair

All the patients were planned for surgery immediately, since early intervention gives better results. But there were some restrictions.

Criteria for percutaneous pinning:

1) Patients who came within 5 days of injury.
2) Without gross oedema of elbow.
3) Without any contraindications for immediate surgery like LRI, and other anesthetic contraindications.

Criteria for ORIF:

1) Patients who came 5 days after injury, in whom percutaneous pinning is difficult.
2) Patients with gross oedema of elbow.
3) Patients in whom percutaneous pinning could not be succeeded.
4) Patients who have to wait for few days for anesthetic fitness for surgery.

Unlike other surgeries in orthopaedics, the implant for our cases were very simple. We used K-wires ranging from 1.2 mm to 2.0 mm according to the age group and the size of the columns of the bone .

During follow up the range of movement of elbow, regaining of normal function and cosmetic appearance were noted.

The following criteria were used

1. Regaining the function of elbow.
2. Avoiding cubitus varus deformity.
3. Early mobilization.
4. Avoiding stiffness of elbow.
5. Surgical scar.

The cases were analysed as per the following criteria:

1. Age
2. Sex
3. Mode of injury
4. Side of upper limb involved
5. Time interval between injury and surgery
6. Type of fracture - Extension

   Flexion
7. Per operative and post operative complication
8. Hospital stay
9. No. of days after which bony union was achieved
10. Removal of K- wires.

Age group:

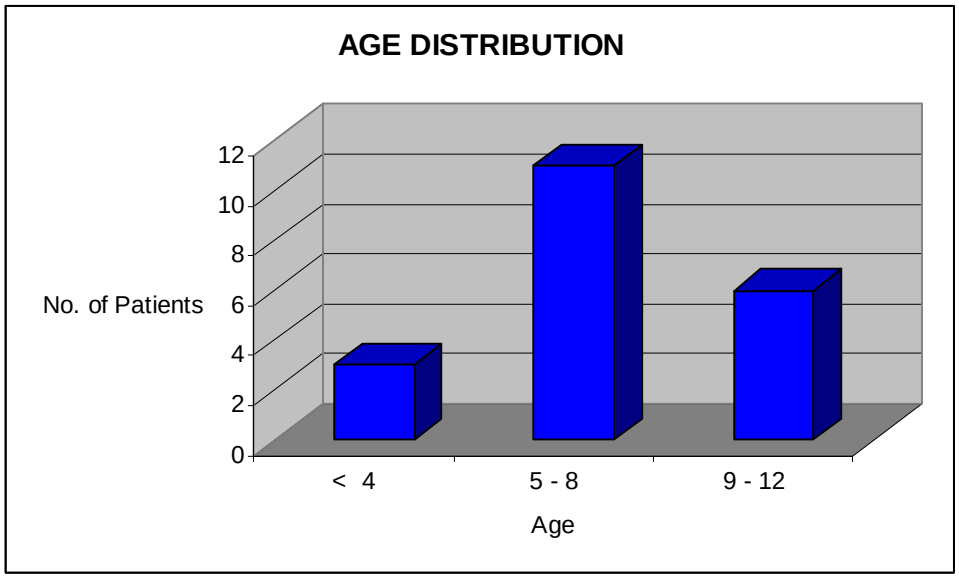
Age group varied from 3 to 12 years. Maximum percentage of patients belonged to the 5 to 8 age group(55%).

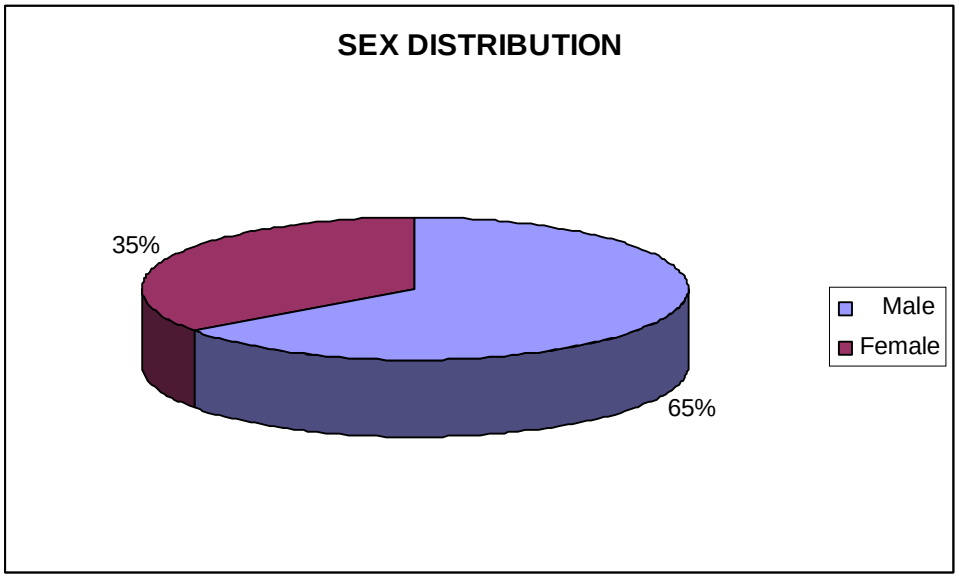
Age group in Years	No. of Cases	Percentage
≤ 4	3	15%
5 - 8	11	55%
9 - 12	6	30%

Sex ratio:

There was a predominance of male children in the ratio of 65:35. This is probably because male children are involved more in out door activities and rough games than female children.

Sex	No. of Patients	Percentage
Male	13	65%
Female	7	35%


AGE DISTRIBUTION
No. of Patients
12
10
8
6
4
2
0
< 4
5 - 8
9 - 12
Age


SEX DISTRIBUTION
35%
65%
Male
Female

Mode of injury:

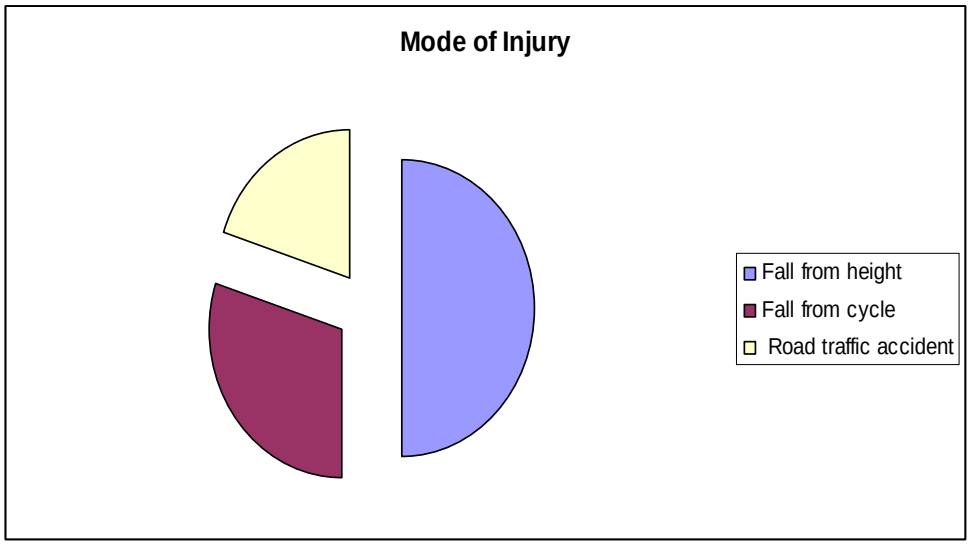
Fall from height (i.e tree, walls) was the most common etiology. Fall from the cycle was the second most common cause, and Road traffic accident comes the third cause.

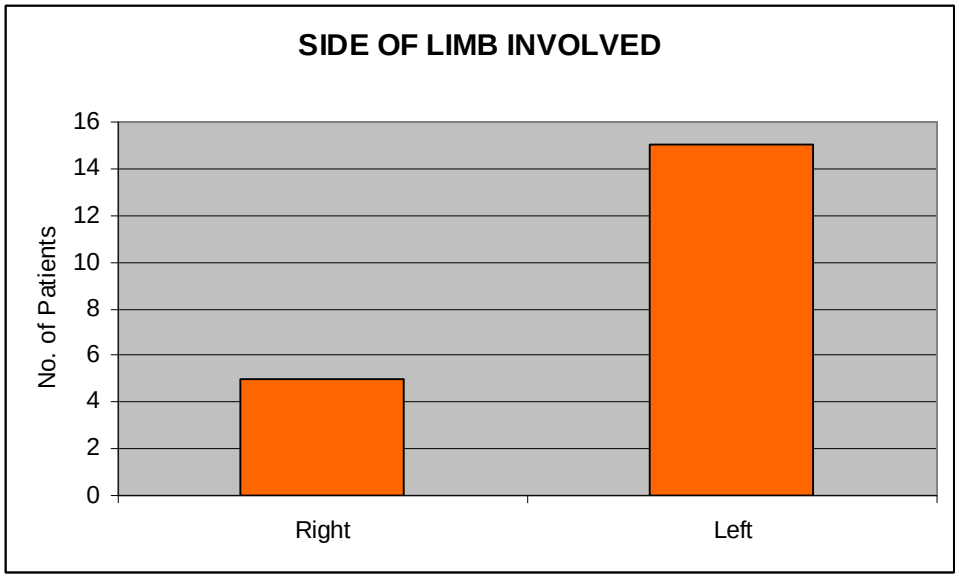
Mechanism of Injury	No. of patients	Percentage
Fall from height	10	50%
Fall from cycle	6	30%
Road traffic accident	4	20%

Side of upperlimb involved:

15 patients (i.e 75 %) had injury in the left humerus and only 5 patients (25%) had injury to the right side humerus.

Side of upperlimb	Number of cases	Percentage
Right	5	25%
Left	15	75%


Mode of Injury
Fall from height
Fall from cycle
Road traffic accident


SIDE OF LIMB INVOLVED
No. of Patients
16
14
12
10
8
6
4
2
0
Right
Left

Time interval between injury and surgery:

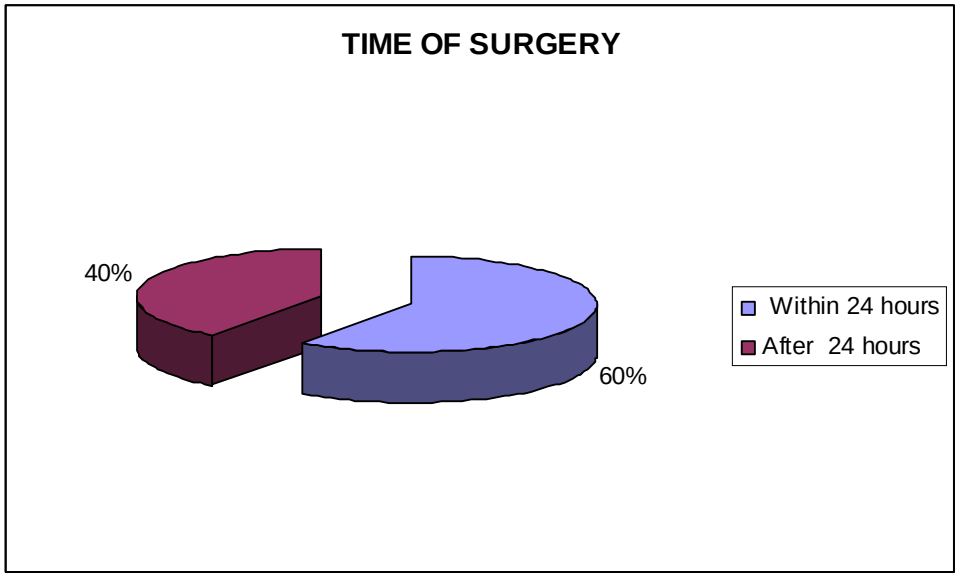
60% of the patients were taken up for surgery within 24 hours either closed pinning or ORIF. Unless and other wise there were any contraindication like lower respiratory tract infection or specific anaesthetic contraindications, immediate fixation was done.

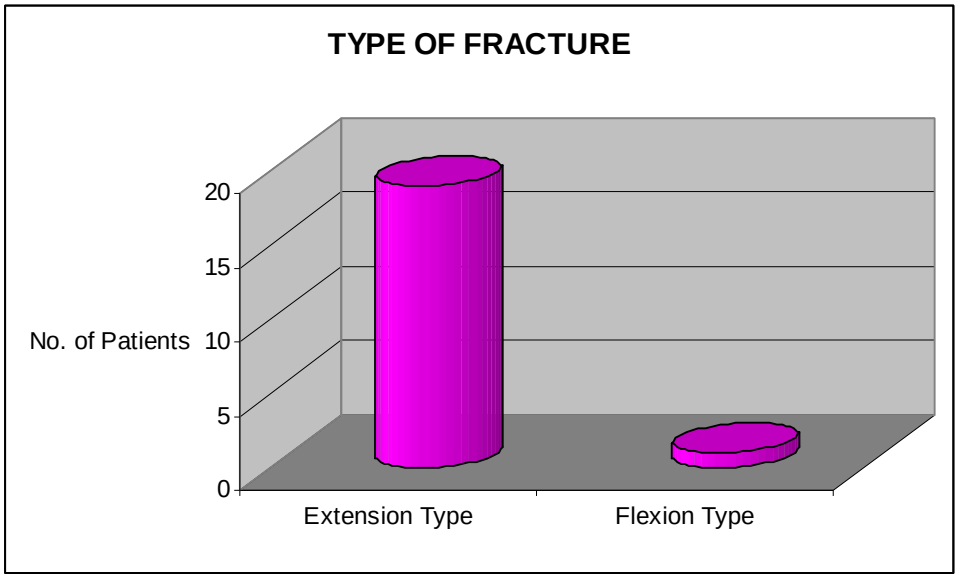
Time of surgery	No. of Patients	Percentage
Within 24 hours	12	60%
After 24 hours	8	40%

Type of fracture:

95% of the cases were of Extension type. Extension type of supracondylar fractures far out numbered flexion type of injuries. The only one case of flexion type had an etiology of fall from height with flexed elbow and landing on the elbow.

Type of injury	No. of Patients	Percentage
Extension type	19	95%
Flexion type	1	5%


TIME OF SURGERY
40%
60%
Within 24 hours
After 24 hours


TYPE OF FRACTURE
No. of Patients
20
15
10
5
0
Extension Type
Flexion Type

Post operative complications:

One patient developed ulnar nerve neuropraxia, which recovered completely within 5 weeks with physiotherapy.

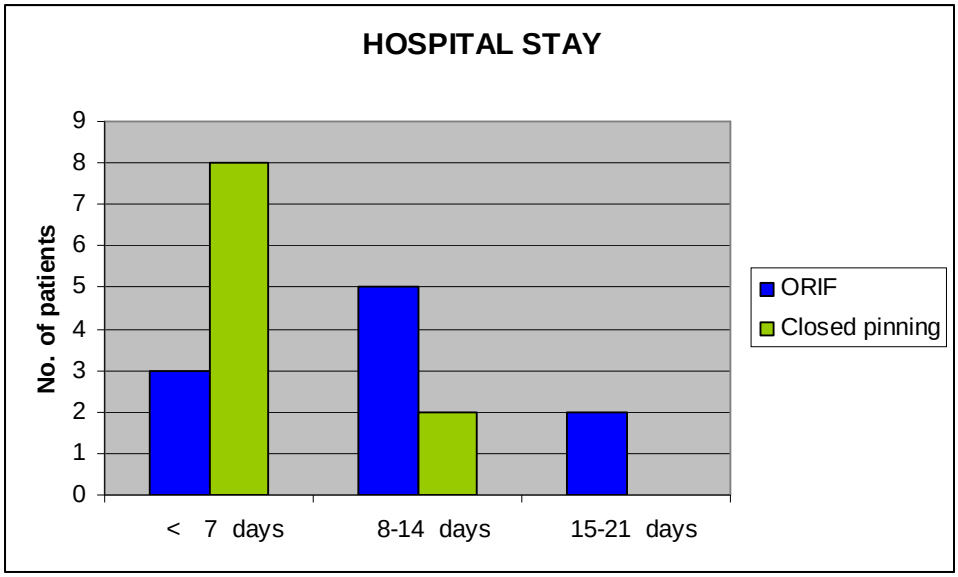
One patient had pin site infection, which settled with IV antibiotics.

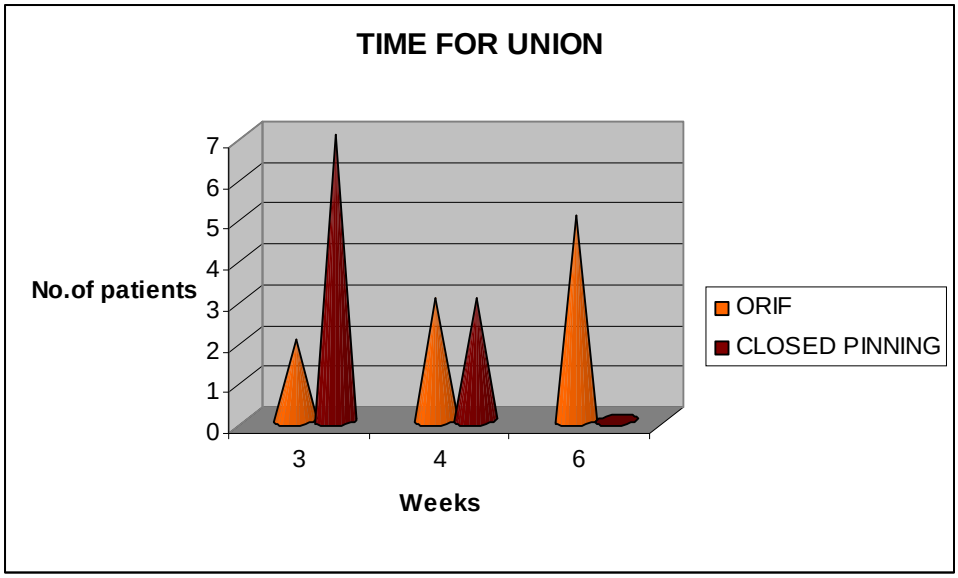
Stiff elbow		Neurovascular Complication (Ulnar nerve)		Volkman's contraction		Cubitus varus deformity		Infection	
ORIF	Closed pinning	ORIF	Closed Pinning	ORIF	Closed pinning	ORIF	Closed pinning	ORIF	Closed pinning
-	-	1	-	-	-	-	-	1	-

Hospital stay:

The hospital stay of 11 patients was less than a week, 7 patients were discharged between 8 and 14 days and the remaining 2 patients was discharged between 15 and 21 days.

No. of Days	**No. of Patients**		**Percentage**	
	ORIF	**Closed pinning**	**ORIF**	**Closed pinning**
< 7 days	3	8	30%	80%
8-14 days	5	2	50%	20%
15-21 days	2	0	20%	0 %


HOSPITAL STAY
No. of patients
9
8
7
6
5
4
3
2
1
0
< 7 days
8-14 days
15-21 days
ORIF
Closed pinning


TIME FOR UNION
No.of patients
7
6
5
4
3
2
1
0
3
4
6
Weeks
ORIF
CLOSED PINNING

Bony union:

Bony union was checked by taking serial x-rays every week in the first month and then once in 2 weeks. Union was assessed by radiological and clinical parameters.

No. of weeks for Union	No. of Patient		Percentage	
	ORIF	Closed pinning	ORIF	Closed pinning
3	2	7	20 %	70 %
4	3	3	30 %	30 %
6	5	0	50%	0%

RADIOLOGICAL CRITERIA USED:

The standard x-rays of the elbow included an antero-posterior view with elbow extended and a lateral view with elbow flexed to 90 degrees and the forearm in neutral. In the injured elbow it is often difficult to extend the elbow, so the Jones view may be taken.

Minimally displaced fractures were identified with the help of anterior humeral line.

ROTATIONAL DISPLACEMENT:

The distal humeral condyles are rotated normally 5° medially to the shaft. In supracondylar fracture there is often a loss of rotational alignment of the shaft with the condyle. This should be appreciated before taking up the patient for surgery, for a proper open reduction.

Technique of Lornoth and Norman for measuring rotational displacement:

Using the routine lateral x-rays in which the tube is directed in a series of gradations from 15° anterior to the shaft to 15° posterior to it. The degree of rotation is determined by the difference in rotation of films showing the shaft is seen in pure lateral profile, with that showing the condyles in pure lateral profile.

STANDARD SURGICAL TECHNIQUES:

1) Closed pinning.

2) Open reduction and internal fixation.

The aim of the surgery was

i) To achieve anatomical reduction and to maintain reduction.

ii) Posteromedial displacement of 5° to 10° was accepted.

iii) No rotational deformity was accepted.

This can be achieved by closed pinning or ORIF.

1) <u>OPEN REDUCTION AND INTERNAL FIXATION</u>:

- General anesthesia/ Supra clavicular block.
- Swimmer's position.
- Sterile preparation and draping.
- Posterior midline incision.
- Skin, sub- cutaneous and deep fascia incised.
- Triceps muscle reached.
- Ulnar nerve identified and isolated.
- Tongue flap made over triceps with apex facing proximally and retracted distally (OR) Triceps muscle is split in mid line.
- Fracture site reached.
- Fragments aligned in position and maintained with reduction clamps.
- Two criss cross K-wires inserted . Both the wires should engage the distal fragment, should pass through the either of the columns, cross the fracture site and penetrate the opposite cortex.
- Lateral K-wire inserted from the lateral condyle avoiding injury to the radial nerve. If two K-wires were to be inserted on the lateral side, the second wire is inserted parallel to previous one.
- Medial K-wire inserted in the centre or anterior aspect of medial epicondyle. Care should be taken not to injure the ulnar nerve.
- Stability of the fracture fragments checked.

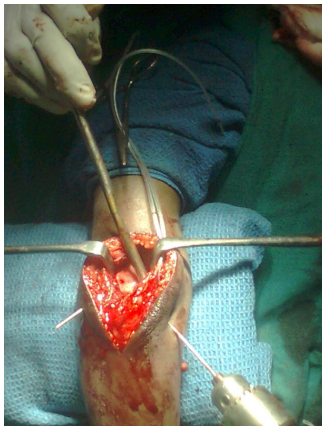
OPEN REDUCTION AND INTERNAL FIXATION

POSTERIOR MID LINE INCISION

ULNAR NERVE ISOLATED

FRACTURE REDUCED

LATERAL PINNING



MEDIAL PINNING

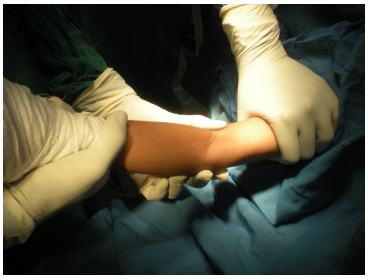
WOUND CLOSED

- Position confirmed by x-ray or C-arm.
- Wound closed in layers.
- Above elbow slab applied with 70 - 90 degrees of flexion.
- Post operatively neurovascular examination done and the patient is checked for any compartmental syndrome.

2) <u>CLOSED PINNING</u>[26] :

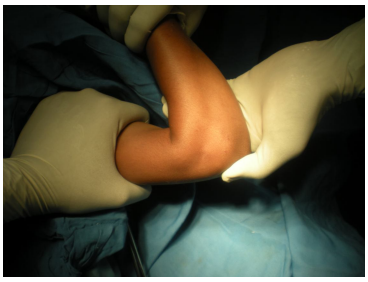
- General anesthesia / supra clavicular block.
- Supine position with shoulder at edge of the table and the arm placed over the side extension.
- Sterile preparation and draping.
- C-arm machine is kept parallel to the table and covered with a sterile drape.
- Correction of medial or lateral translation is done by applying a translation force with valgus or varus moment in the coronal plane to the distal fragment.
- Correction of rotation done by supination or pronation of the forearm. Posteromedial rotation needs supination and posterolateral rotation needs pronation.

PERCUTANEOUS PINNING

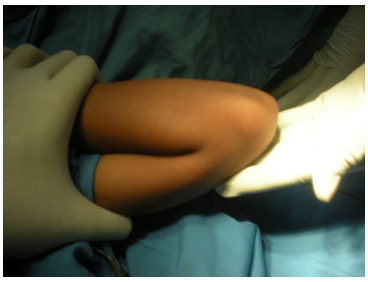


LATERAL TRANSLATION CORRECTED

ROTATION DEFORMITY CORRECTED

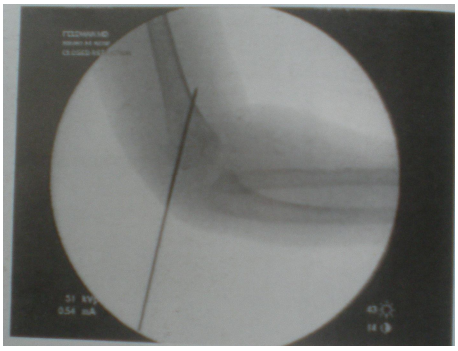


CORRECTION OF POSTERIOR DISPLACEMENT

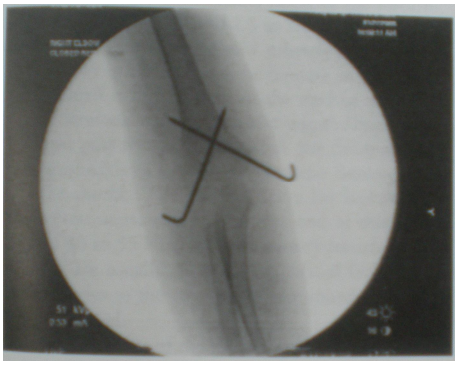


ELBOW IN FULL FLEXION

LATERAL PINNING



MEDIAL PINNING

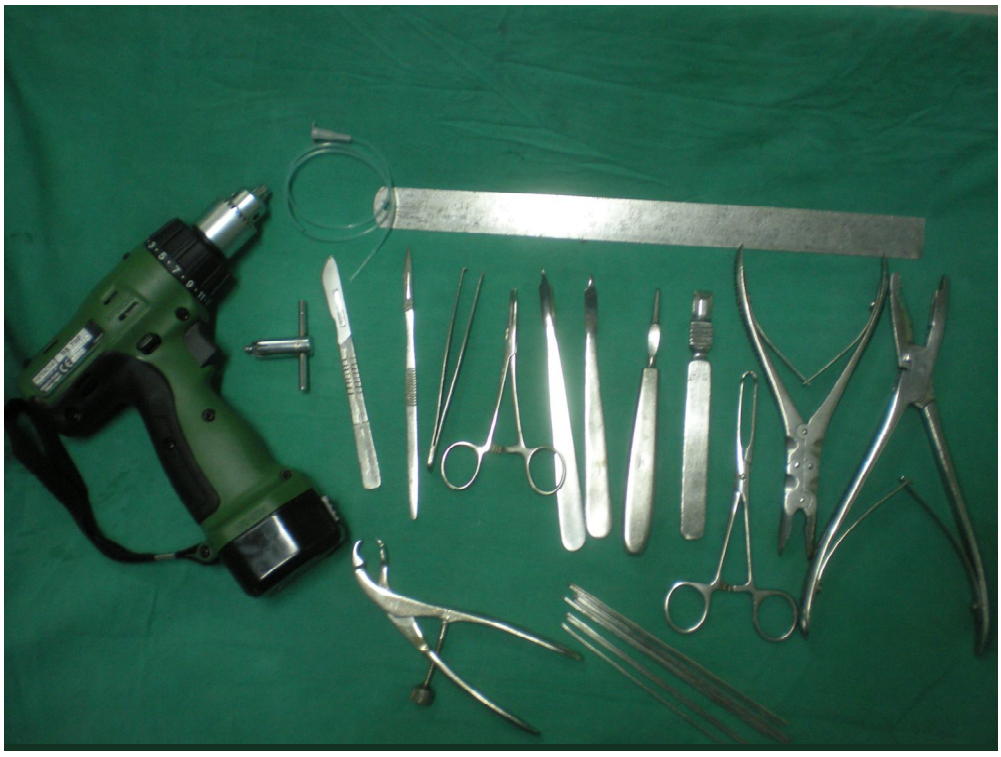


C-ARM IMAGES

- If rotatory correction is satisfactory, elbow is kept flexed to maintain the rotational stability.
- Correction of posterior displacement or angulation is done by lifting the distal fragment anteriorly with the help of the surgeons thumb placed over the olecranon process.
- The elbow is further flexed during this maneuver to tighten the posterior periosteal hinge and reduce the fracture completely.
- Pronation may be needed in full flexion in order to lock the fracture fragments.
- Position confirmed by C-arm imaging using AP and Lateral views. Jones view is also used.
- Now the K-wires are inserted. Both the K-wires were inserted 30° oriented to the long axis of humerus. The K-wires must engage the distal fragment, should pass through the medial and lateral columns, cross the fracture site and penetrate the opposite cortex.
- Lateral K-wire is inserted first , while the surgeon hold the elbow in acute flexion and by palpating the lateral condyle. Care should be taken not to injure the radial nerve.
- If two K-wires are to be inserted on the lateral side, the second wire is inserted medial to the previous one. Both the pins should be slightly convergent from proximal to distal.

INSTRUMENTS USED FOR PERCUTANEOUS

PINNING AND ORIF



- Medial K-wire inserted in the centre or anterior aspect of medial epicondyle and is directed from anteromedial to posterolateral. Care should be taken not to injure the ulnar nerve.
- After pin fixation, the position is confirmed by C-arm images.
- After acceptable reduction, the K-wires are cut and bend for easy removal.
- Pin site dressing done.
- Above elbow slab applied with 70 - 90 degrees of flexion.
- Post operatively neurovascular examination done and the patient is checked for any compartmental syndrome.

MOBILISATION AND REMOVAL OF K-WIRES:

Out of 10 cases treated by percutaneous pinning, the mobilisation was started between 7 to 10 days with K-wire in situ, while the mobilisation was started between 10 and 14 days with K-wire in situ for the other patients who were treated by ORIF.

The sutures were removed on 14th post operative day for the patients treated by ORIF.

K-wires were removed either on the 3^{rd} or the 4^{th} week depending on the age of the patient.

POST OPERATIVE PEROID:

The patients were reviewed every week for the first month and then biweekly for next 2 months and then every month for the next 3 months, totally for a period of 6 months.

The results were graded using the **FLYNN CRITERIA[27].**

Results	**Cosmetic factor (loss of carrying angle in degrees)**	**Functional factor (loss of motion in degrees)**
Excellent	0 - 5	0 – 5
Good	6 - 10	6 - 10
Fair	11 - 15	11 – 15
Poor	> 15	> 15

CASE

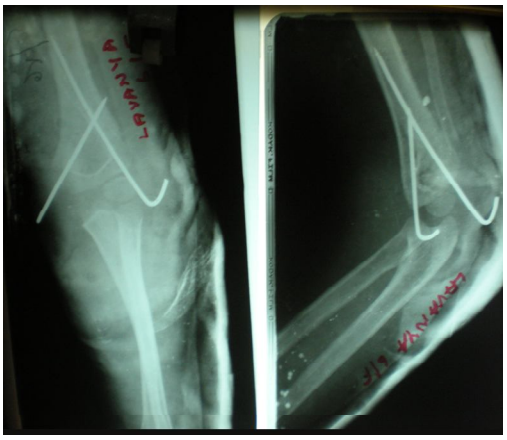
ILLUSTRATIONS

CASE – 1

Name	: Lavanya
Age / Sex	: 6 yrs / Female
IP Number	: 924919
Mode of Injury	: Road traffic accident
Side of upper limb	: Left
GARTLAND'S Type	: III
Procedure	: Percutaneous pinning (Criss cross K-wire)
Post op period	: Uneventful
Mobilisation	: 7 days
Hospital stay	: 8 days
Union in weeks	: 3
K- wire Removal	: 3 weeks
FLYNN Criteria (Follow up 6 months)	: Functional - 4 Cosmetic – 4.

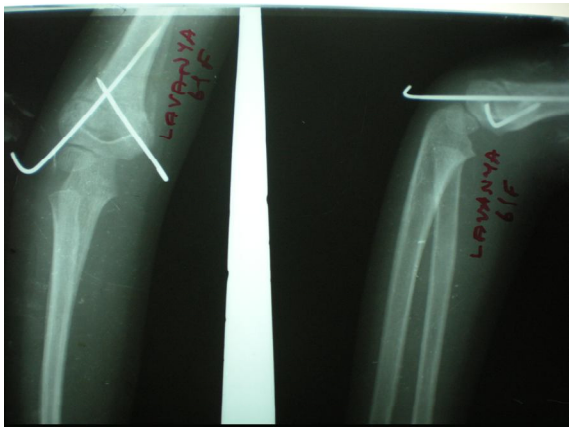
CASE -1

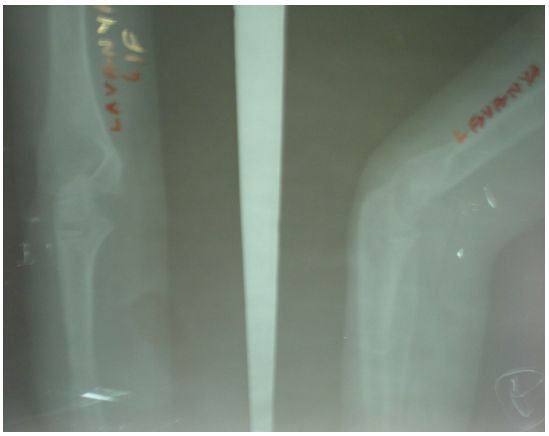
PERCUTANEOUS PINNING



PRE – OP

POST - OP





3 WEEKS POST OP

6 MONTHS FOLLOW UP

CASE- 1

PERCUTANEOUS PINNING → 6 MONTHS FOLLOW UP

FULL EXTENSION
NO VARUS OR VALGUS

FULL FLEXION

POSTERIORLY NO SCAR

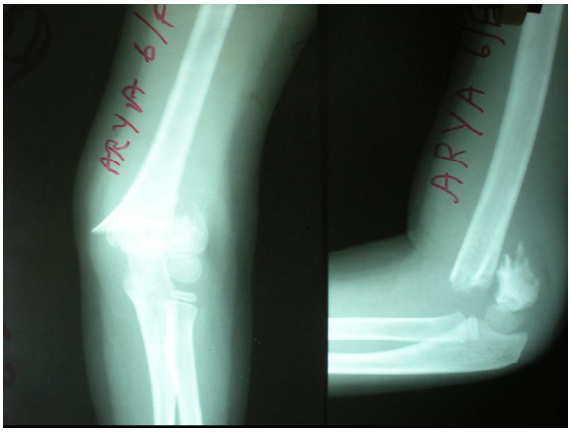
SMALL SCAR OVER ENTRY POINT OF K- WIRE

CASE – 2

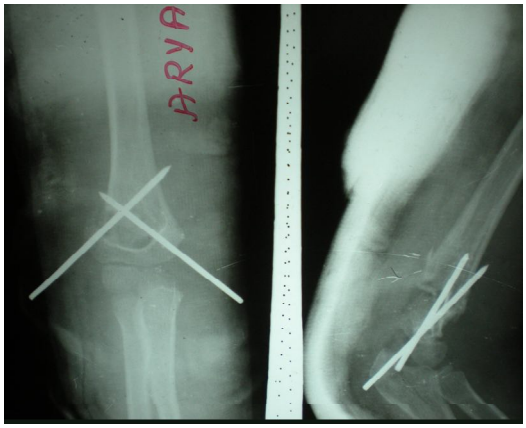
Name	: Arya
Age / Sex	: 6 yrs / Female
IP Number	: 941992
Mode of Injury	: Fall from height
Side of upper limb	: Right
GARTLAND'S Type	: III
Procedure	: Percutaneous pinning (Criss cross K-wire)
Post op period	: Uneventful
Mobilisation	: 7 days
Hospital stay	: 7 days
Union in weeks	: 3
K- wire Removal	: 3 weeks
FLYNN Criteria (Follow up 6 months)	: Functional - 4 Cosmetic – 4.

CASE -2

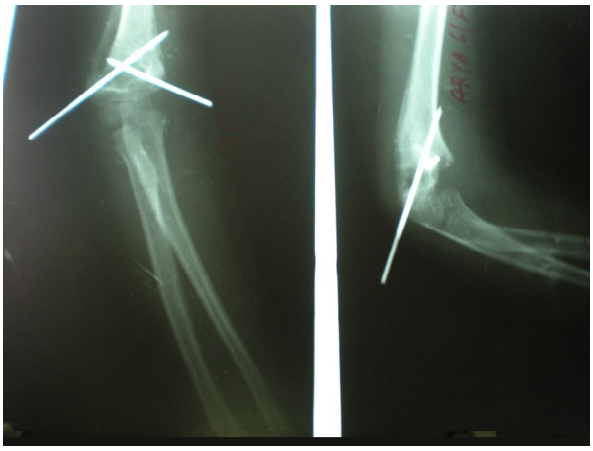
PERCUTANEOUS PINNING



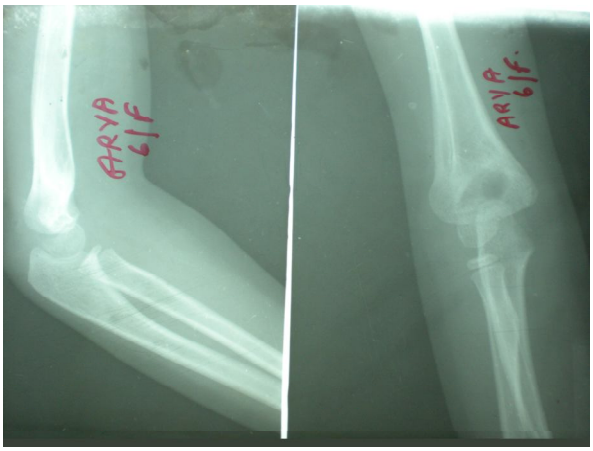
PRE-OP



POST-OP



3 WEEKS POST – OP



6 MONTHS FOLLOW UP

CASE -2

PERCUTANEOUS PINNING → 6 MONTHS FOLLOW UP

FULL EXTENSION
NO VARUS OR VALGUS

FULL FLEXION

POSTERIORLY NO SCAR

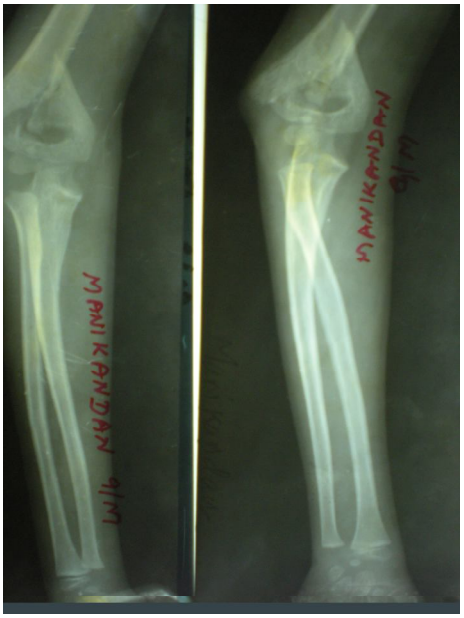
SMALL SCAR OVER ENTRY POINT OF K-WIRE

CASE – 3

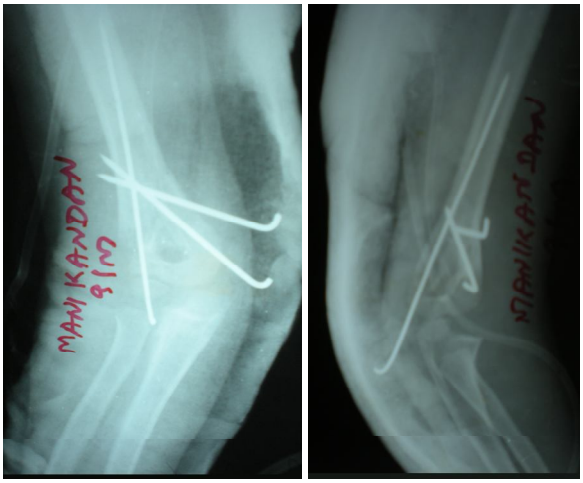
Name	: Manikandan
Age / Sex	: 9 yrs/ Male
IP Number	: 941757
Mode of Injury	: Fall from cycle
Side of upper limb	: Left
GARTLAND'S Type	: III
Procedure	: ORIF (2 lateral & 1 medial K-wire)
Post op period	: Uneventful
Mobilisation	: 10 days
Hospital stay	: 13 days
Union in weeks	: 6
K- wire Removal	: 4 weeks
FLYNN Criteria (Follow up 6 months)	: Functional - 4 Cosmetic – 4

CASE - 3

OPEN REDUCTION AND INTERNAL FIXATION

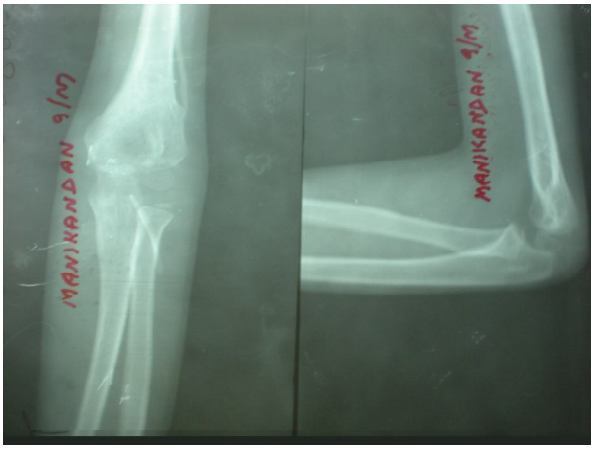


PRE – OP



POST - OP

3 WEEKS POST – OP



6 MONTHS FOLLOW UP

CASE - 3

ORIF → 6 MONTHS FOLLOW UP

FULL EXTENSION
NO VARUS OR VALGUS

FULL FLEXION

POSTERIOR LARGE SCAR

CASE – 4

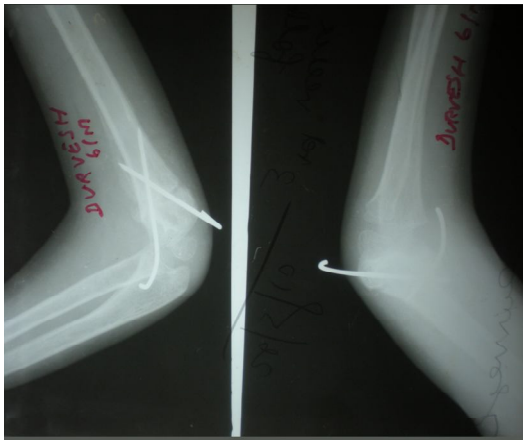
Name	: Durvesh
Age / Sex	: 6 yrs/ Male
IP Number	: 947681
Mode of Injury	: Fall from cycle
Side of upper limb	: Left
GARTLAND'S Type	: III
Procedure	: ORIF (Criss cross K-wire)
Post op period	: Uneventful
Mobilisation	: 10 days
Hospital stay	: 5 days
Union in weeks	: 3
K- wire Removal	: 3 weeks
FLYNN Criteria (Follow up 6 months)	: Functional - 4 Cosmetic – 4.

CASE – 4

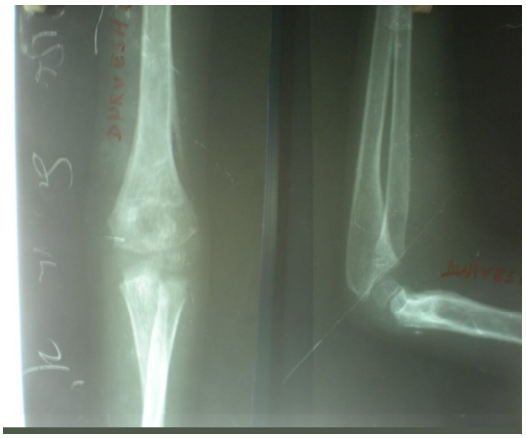
OPEN REDUCTION AND INTERNAL FIXATION

PRE – OP

POST - OP



3 WEEKS POST – OP



6 MONTHS FOLLOW UP

CASE - 4

ORIF → 6 MONTHS FOLLOW UP

FULL EXTENSION
NO VARUS OR VALGUS

FULL FLEXION

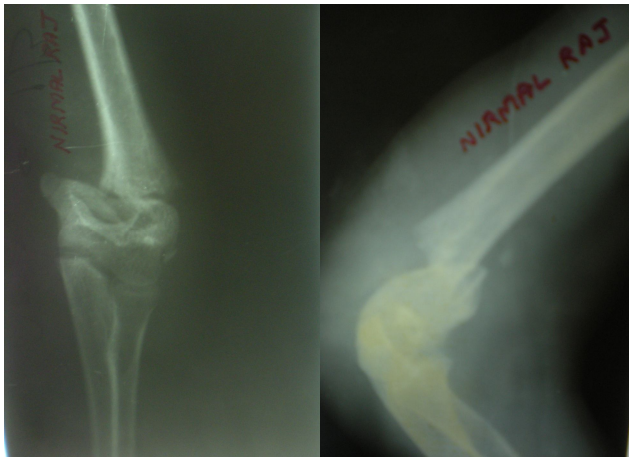
POSTERIOR LARGE SCAR

CASE – 5

Name	: Nirmal raj
Age / Sex	: 12 yrs/ Male
IP Number	: 943884
Mode of Injury	: Fall from height (**Elbow flexed**)
Side of upper limb	: Left
Type of Fracture	: **Flexion Type**
Procedure	: ORIF (2 lateral & 1 medial K-wire)
Post op period	: Uneventful
Mobilisation	: 10 days
Hospital stay	: 10 days
Union in weeks	: 6
K- wire Removal	: 4 weeks
FLYNN Criteria (Follow up 6 months)	: Functional - 4 Cosmetic – 4.

CASE - 5

FLEXION TYPE → OPEN REDUCTION AND INTERNAL FIXATION



PRE-OP

POST-OP

I MONTH POST-OP

RESULT

RESULT

All the relevant data were analysed.

The fracture was more in the age group of 5 – 8 yrs. Peak incidence for the supracondylar fractures of humerus is 6.7 yrs.

Boys had higher incidence compared to the girls in the ratio of 65:35. This incidence was similar to that study conducted by Celiker et al[28].

Though the mechanism of injury is fall on outstretched hand, the common mode of injury was fall from height like wall, trees, etc.

Left upper limb or the non dominant side was more involved than the right or dominant side.

About 60% of patients were operated within 24 hours of injury and the rest were operated later.

Extension types were 19 patients(95%) of our study and only one patient (5%) was of flexion type. This inference correlates wih the study by Cekanauskas et al[29]. Of the extension type, 15 patients (75%) were of type III and 4 patients (20%) were of Type II.

About 80% of the patients who were treated by percutaneous pinning were discharged within 7 days, but only 30% of the patients who were treated by ORIF were discharged within the same period.

In about 70 % of the patients treated by percutaneous pinning, fracture united in 3 weeks and in only 20% of the patients treated by ORIF did so in the same time. 30% of the patients from the both groups had union in 4 weeks. 50% of the patients treated by ORIF had union by the 6^{th} week.

All the patients were graded as per the **FLYNN CRITERIA**. In our study, all the patients treated by both means either ORIF or percutaneous pinning had an excellent result.

In our study, 1 patient developed ulnar nerve neuropraxia post operatively, which recovered completely in 5 weeks, following physiotherapy. One more patient had a pin site infection, which settled with IV antibiotics.

DISCUSSION

DISCUSSION

Mercer Rang said “Pity the young surgeon whose first case is a fracture around elbow”[30]. Proper training is needed to adopt recent advances by young surgeons to deal with these challenges[31]. Though this statement is for the young surgeons, even experienced surgeons sometimes have difficulty in treating supracondylar fractures.

Supracondylar fracture of humerus in children are still difficult to handle because of the age group involved, the neurovascular structures and difficulty in achieving anatomical reduction by closed means.

To obtain a perfect result after a supracondylar fracture of the humerus, an accurate anatomical reduction is needed. It is essential to minimize additional trauma to the already traumatized joint and periarticular tissues. This is more in ORIF, though it may also happen if repeated attempts are made in percutaneous pinning.

Fracture healing is delayed in cases treated by ORIF, due to further stripping of periosteum per operatively, in addition to that has happened during the injury. This damage to the periosteum is not there in percutaneous pinning.

The best treatment for supracondylar fracture of the humerus must provide an excellent functional result and an elbow of normal appearance with minimal risk to the patient. Either of the procedures ORIF or percutaneous pinning has merits and demerits.

CRITERIA	ORIF	PERCUTANEOUS PINNING
Surgical Expense	More	Less
Stay in hospital	More	Less
Mobilisation	Late	Early
Cosmetic appearance	Big scar	No scar
Union	Late	Early
Technical difficulty	Less	More
Surgical time	More	Less
Chance of infection	More	Less
Soft tissue damage	More	Less

From the functional stand point, limitation of flexion of the elbow is considered more disabling than the extension. Next impairment comes the change in carrying angle, which may result in tardy ulnar nerve palsy.

The patient may develop cubitus varus deformity, which disturbs the patient cosmetically. More over the patient treated by ORIF may have a large scar in addition to that.

It is generally agreed that accurate reduction is not necessary for an excellent functional result because of the great remodeling power in children (Attenburg Et Al, Laurance 1957). But it is also true that the cosmetic end results of such a treatment are often poor.

Moreover union is never a problem in supracondylar fracture of humerus in paeditric age group, but the problems to be kept in mind are

i) Early neurovascular injury

ii) Long term complications like Volkmann's ischemic contracture, Myositis ossificans, Cubitus varus or valgus deformity, Tardy ulnar nerve palsy.

Of all these complications, cubitus varus is the most common complication.

Kaewpornsawan study[32] states that both treatments gave good results. Closed reduction should be performed first and, if it fails, then open reduction can be performed. This will produce good results in the hands of an experienced surgeon.

CONCLUSION

CONCLUSION

Though both the procedures either ORIF or percutaneous pinning, gave excellent results functionally, we conclude that percutaneous pinning is the better option for supracondylar fractures of humerus for the following reasons

1) The cosmetic results was better
2) Cost effective
3) Stay in hospital was less
4) Complications are less
5) Union was earlier.

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BIBLIOGRAPHY

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PROFORMA

PROFORMA

1. Name:
2. Age/ sex:
3. Address:
4. Contact number:
5. Associated Medical illness:
6. Involved side:
7. Time and date of surgery:
8. Time of arrival to hospital:
9. In patient No:
10. Mode of Injury:
11. Treatment History:
12. Clinical examination:
13. Associated Injuries:
14. Gartland Classification:
15. Initial management:
16. Preoperative antibiotics used:
17. Time interval between arrival and surgery:
18. Date of surgery:

19. Type of anaesthesia:

20.Preoperative X-rays:

21.Surgical procedure:

22.Approach used:

23.Difficulty during surgery:

24.Post operative X-rays:

25.DT removed on:

26.SR done on:

27.Mobilisation started on:

28.K-wire removed on:

29.Post operative complications:

30.Follow up:

31.FLYNN CRITERIA:

MASTER CHART

CASES TREATED BY PERCUTANEOUS PINNING FOLLOW UP 6 MONTHS

S. No	Name	Age/ sex	IP number	Mode of injury	Side	Gartland Type	DOA	DOS	Hospital stay	Union in Weeks	Complications	FLYNN CRITERIA	
												Functional	Cosmetic
1	Manikandan	7/M	904970	Fall from height	Right	III	17.08.08	18.08.08	4 days	4	Nil	4	4
2	Anandaperumal	6/M	913970	Fall from cycle	Left	III	12.12.08	13.12.08	5 days	3	Nil	4	4
3	Hari Krishnan	6/M	917064	Fall from height	Left	III	30.01.09	03.02.09	8 days	3	Nil	4	4
4	Shiyaz	8/M	922145	Fall from height	Left	II	19.04.09	20.04.09	4 days	4	Nil	4	4
5	Lavanya	6/F	924919	RTA	Left	III	26.05.09	29.05.09	8 days	3	Nil	4	4
6	Srinithi	4/F	926306	Fall from height	Left	III	15.06.09	16.06.09	4 days	3	Nil	4	4
7	Kesavan	6/M	932802	Fall from height	Right	II	13.09.09	14.09.09	5 days	3	Nil	4	4
8	Suriya	3/F	936001	Fall from cycle	Left	III	27.10.09	28.10.09	6 days	3	Nil	4	4
9	Arya	6/F	941992	Fall from height	Right	III	01.02.10	03.02.10	7 days	3	Nil	4	4
10	Surendran	10/M	942390	Fall from height	Left	II	05.02.10	06.02.10	6 days	4	Nil	4	4

DOA Date of Admission

DOS Date of Surgery

CASES TREATED BY ORIF FOLLOW UP 6 MONTHS

S. No	Name	Age/ sex	IP number	Mode of injury	Side	Gartland Type	DOA	DOS	Hospital stay	Union in Weeks	Complications	FLYNN CRITERIA	
												Functional	Cosmetic
1	Aswathi	4/F	902440	RTA	Left	III	11.07.08	11.07.08	5 days	3	Nil	4	4
2	Suriya	7/M	908245	Fall from height	Left	III	30.09.08	01.10.08	7 days	4	Nil	4	4
3	Ranjith kumar	10/M	916710	Fall from cycle	Left	II	26.01.09	29.01.09	18 days	6	Pin site infection	4	4
4	Britto	11/M	920019	Fall from height	Left	III	16.03.09	19.03.09	8 days	6	Nil	4	4
5	Karthik	9/M	926306	RTA	Left	III	10.06.09	16.06.09	12 days	6	Nil	4	4
6	Savitha	5/F	930344	Fall from cycle	Right	III	12.08.09	13.08.09	20 days	4	Ulnar Nerve Neuropraxia	4	4
7	Malini	6/F	936149	RTA	Right	III	29.10.09	29.10.09	8 days	4	Nil	4	4
8	Manikandan	9/M	941757	Fall from cycle	Left	III	27.01.10	30.01.10	13 days	6	Nil	4	4
9	Nirmal Raj	12/M	943384	Fall from height	Left	FLEXION TYPE	19.02.10	23.02.10	10 days	6	Nil	4	4
10	Durvesh	6/M	947681	Fall from cycle	Left	III	26.04.10	26.04.10	5 days	3	Nil	4	4

DOA Date of Admission

DOS Date of Surgery